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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1477

Washington, D. C. ▼ October, 1927

VARIETAL CHARACTERISTICS OF PLUMS IN THE PACIFIC STATES IN RELATION TO PRUNING

By

C. F. KINMAN, Associate Pomologist, Office of Horticulture
Bureau of Plant Industry

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IMPORTANCE OF PRUNING OPERATIONS

Probably nowhere in the United States is the pruning of deciduous fruit trees more important or more varied than in the plum-growing sections [1] of the Pacific States, where this important fruit industry is distributed over a large area. In this region the summer rainfall is very light, soils and temperatures are variable as between different fruit-growing sections, and only large fruit is profitable for shipment to distant markets. Pruning has become a very important factor in obtaining the regular production of large fruit and in maintaining the vigor of the trees. It has become one of the principal operations of orchard management, and the variations in the operation which may prove beneficial in different sections and with the different varieties are of great interest and importance.

A greater number of varieties in general cultivation are included in the plum and prune-producing industry than may be found with almost any other commercially grown fruit in this region. As each variety possesses its peculiar and usually striking habits of growth and production and responds in its peculiar way to local environment and treatment, it is essential that the pruner have an intimate

[1] For information on plum culture, see KINMAN, C. F. PLUM AND PRUNE GROWING IN THE PACIFIC STATES. U. S. Dept. Agr. Farmers' Bull. 1372, 59 pp., illus. 1924.

knowledge of the behavior of his different varieties if the best results are to be obtained.

Plums, as well as other fruits in this section, are quickly affected by lack of water for irrigation, variation in depth and fertility of soil, and extremes in summer temperatures; and various combinations of these conditions are found in the plum-growing localities. The great diversity found between the performance of different commercially grown varieties may also be explained in part by the fact that among them are represented several species including *Prunus domestica*, *P. salicina* (*triflora*), *P. simoni*, and probably native American types either by true forms or hybrids.

When planting a western plum orchard for the purpose of producing fruit for fresh shipment, varieties are chosen which will ripen their fruit in such order as to make an uninterrupted and extended harvest. As the ripening period of a variety continues for a few days only, depending upon the locality and the variety, several varieties, usually from 1 to 24 or more, are needed to extend the harvest over a satisfactory period. The orchard of only a few acres often has as many varieties as the large one, if plums are the main crop or are grown exclusively. Where the fruit is grown for drying to prunes, only a small number of varieties is chosen, often only one or two; but here, as with the fruit for fresh shipment, the large-sized fruit is usually the most profitable and the variations in habits of growth of individual varieties are striking, and a real knowledge of them is needed by the grower and pruner just as with fruit for fresh shipment.

If pollination is provided for, there need be little fear in the Pacific States as to the setting of a large crop of plums. Unless frost injures the blossoms or small fruit soon after it sets, the crop will be excessive and an expensive fruit-thinning operation necessary. This is regardless of any of the common pruning practices. Though the pruning is often relied upon to remove some of the bearing wood in order to lighten the crop and to distribute the load over the tree, a variation in the pruning method to encourage fruitfulness is seldom, if ever, necessary when bearing plum trees are pruned.

The general pruning practice which has been evolved to meet the various conditions consists largely in the cutting back of the previous season's growth and some thinning out of branches. The quantity of wood removed is determined very largely by local conditions and the use which is to be made of the fruit. When water for irrigation is scarce or soils poor, severe and regular heading back of the previous year's growth is needed to induce the fruit to grow to sufficient size to be profitable for fresh shipment (pl. 1, A and B). Where soils are fertile and well irrigated, regular heading back and thinning out of fruiting branches is done for the purpose of preventing too tall a growth of the tree, to admit light, to lighten the crop on the tree, and to insure large fruit (pl. 1, C and D). By following these general rules in pruning, the habits of growth and production peculiar to the variety, although often very pronounced and important, are liable to be overlooked or considered in only a general way.

In the preparation of the following discussion of the principal commercial varieties of plums grown in the Pacific States, it has

been the intention to record the varietal characteristics of growth and production which should influence the pruning practice, and to indicate some of the effects of pruning and of natural conditions on the behavior of the tree. It is not the intention to give a detailed pruning method for each different variety, but rather to point out the important differences in the habits of varieties and to guide and encourage the grower in the study of his trees. It has not been the aim to include the general subject of plum culture, but rather to note the behavior of the tree; not to suggest changes in treatment or to point out faults in environment, but to observe the general results of these things. The purpose has been that of a variety study rather than a pruning experiment—an inquiry into the peculiar habits of growth and production of trees of different varieties, rather than to apply a peculiar pruning practice or cultural treatment and observe the reaction. The object has been to observe the response of the different varieties to the type, variations, and severity of pruning practiced by different orchardists and under different soil and climatic environment, for the purpose of learning the fundamental characteristics of the variety and what the variety wishes to do and how it wishes to grow, rather than to show the benefits of certain pruning treatments or to test its ability to withstand them. Trees of some varieties make an upright and compact growth and those of others open and spreading. Some bear their fruit on spurs and others on twigs which grew the previous season. Some retain their spurs longer than others, and some are more inclined than others to replace spurs which have been broken off. These and many other tendencies which may be found by studying the commonly grown varieties of plums are all readily influenced, although to a varying degree, by the local environment and cultural treatment.

It is necessary to have a thorough knowledge of the tendencies of a variety in order to decide upon the peculiar phase of a pruning method best suited for it. By carefully observing trees of different varieties and their growth in different sections and noting their response to the pruning treatment given by different orchardists, many varietal traits which should have a bearing on the type of pruning given them may be readily seen. The general understanding of the effect of different growing conditions and treatments on a variety gives a true idea of its habits and tendencies and therefore provides a reliable foundation on which a pruning practice may be based. A thorough knowledge of the tendencies of a variety is indispensable to the adoption of a wise pruning method. It is also of importance in choosing varieties for an orchard and in plum breeding. An arbitrary and restricted pruning practice, if applied to more than one of the small groups of varieties which are similar in their performance, can but oppose the development of some varieties.

To maintain thrifty, vigorous trees which produce good and regular crops of large-sized fruit—all highly desirable if not essential to profitable plum-growing—it is important that the grower acquire an accurate knowledge of the characteristic habits of his trees so that he may cooperate with them rather than oppose some or many of them by giving all the same pruning treatment. Regular, although moderate, opposition to the tree in pruning may be said to throw

the tree out of its regular balance of growth and production. An occasional excessive pruning may strongly oppose the natural tendencies of growth and prove to be a costly mistake.

EXPLANATIONS OF TERMS USED

Training, or the shaping treatment given the young tree, is considered somewhat distinct from pruning and is not discussed in this bulletin. Unless otherwise stated it is understood that the trees under consideration are those of normal vigor, growing in suitable soil which is of moderate depth and fertility, given some irrigation, making a moderate annual growth, and bearing regular and moderate crops.

Heading back, as used here, refers to the cutting back of 1-year-old shoots. With some fruit growers heading back is used to mean cutting well back into the old wood for the purpose of developing a new top of fruiting branches. This is done particularly with peaches in some parts of the country, but is rarely practiced in the West with plums.

The terms used to indicate different parts of the tree are presumed to be self-explanatory.

Framework branches denote those which grow from the trunk of the tree, and secondary branches those which grow from the framework branches. Next are the fruiting branches, and on these are twigs, spurlike twigs, and spurs (pl. 2, A). A spurlike twig is a growth which, because of unfavorable conditions, has failed to make more than a very short development and resembles a spur more than a twig. Such twigs are often unbranched or the branches are short and spurlike. When favorable growing conditions recur a normal twig grows from the terminal bud. Twiglike spurs are normal spurs which branch but little, if any, but become long by the annual growth from the terminal bud (see pl. 9, D). Spur twigs are short twigs that grow from vigorous branches or spurs which produce lateral spurs and a terminal spur but are not inclined to produce new twigs (see pl. 32, C). If twigs do grow from them they produce spurs the same as the ones on which they grow. Twigs grow from the main wood of a shoot, branch, or twig, but are slender and grow to a few inches or more in length. Some twigs branch more or less freely, and the terminal buds of both the main twig and its strongest branches send out a few inches of new growth each year. The weaker lateral branches of twigs often make but a short spurlike growth and die after fruiting. When growing conditions are unfavorable, many or all twigs are short, and many make but a spurlike terminal growth for one or more years or until conditions for growth improve.

GROWING HABITS OF PLUM TREES IN RELATION TO PRUNING

In training the young tree and in maintaining its shape and vigor when in bearing, the pruner should carefully consider the varietal characteristics of growth and production, such as the tendency to grow erect or spreading, open or compact, to make long or short annual wood growth, to maintain vegetative vigor, and the inclination to produce twigs or spurs.

Trees which make an erect growth often produce numerous long, stout, new shoots and a compact top and require thinning out of branches at pruning time to admit light to the interior of the tree. If the seasonal growth of shoots is short on varieties inclined to make a vigorous growth, yearly cutting back at pruning time is usually required to induce the production of large fruit. This is more especially true if the season's growing conditions are somewhat unfavorable or where the plantings are in a location unsuited to the variety. If the trees grow well and are naturally spreading or open, a pruning practice is needed which will insure strong branches to carry the load of fruit as well as to insure fruit of large size. Between the decidedly upright and the typically spreading trees mentioned there are intermediate types representing both the triflora (*Prunus salicina*) or Japanese group and the domestica or European group.

Of the varieties which are naturally upright in growth, the Santa Rosa and Wickson are examples of the Japanese group and Giant, Pond, and Sergeant of the domestica. Left unpruned or pruned but lightly, bearing trees of these varieties will assume a spreading position, because of the relatively slender growth of the new wood and the weight of fruit. Upright-growing trees of the domestica group are much more easily trained to the desired open shapes than are those of the triflora, as their branches are inclined to grow at a wider angle. With some of the domestica varieties many of the smaller fruiting branches and twigs are slender and hang from the larger branches after they have been brought to this position by a load of fruit. The Giant, Diamond, German Prune, and Lincoln illustrate this type as contrasted with trees with stouter fruiting wood, such as the Clyman, Sergeant, Imperial Epineuse, and President. Burbank of the Japanese group, Climax and Apple of the American-Japanese hybrid group, and California Blue, Reine Claude, and Peach of the domestica group are examples of varieties which are naturally open and spreading rather than drooping. These varieties represent extremes in habits relative to the form of tree. Most varieties are between them in natural form.

The round-topped, open tree of moderate growth is the most desirable from the standpoint of convenience in cultivation, pruning, and spraying, for productiveness, and for strength required to carry a heavy load of fruit. Most varieties deviate somewhat from the ideal in their natural growth, but a satisfactory form may be approached by training the young tree. With the more extreme types, however, the ideal form may be only approximately maintained and this only by a careful and persistent selection of branches when pruning. The Jefferson, a variety inclined to make but little wood growth, and the Santa Rosa, one which grows vigorously, are examples of two of these types. The removal of enough wood at any one pruning to cause a radical change in the form of the tree will stimulate a rampant growth and make much subsequent reshaping of the tree necessary. This rank growth of new wood of undesirable form resulting from severe pruning is more apparent with trees which make an erect, compact growth, as does the Santa Rosa, than with those which are naturally spreading, like the Burbank.

Trees of many varieties which produce a heavy new growth and form compact tops require thinning of branches to admit sufficient light for the thrifty growth of fruiting wood in the interior of the tree. With other varieties which are very open and make but a short new growth, it is preferable to cut back the larger new shoots rather than to remove them. This provides for the growth of new wood needed to maintain the desired vigor for the production of large fruit and to protect the larger branches against sunburn. Jefferson, California Blue, and Golden Drop are among those which grow more slowly. Clyman and Sergeant are representative of those that are also open but are more vigorous. The trees of these varieties soon become very spreading and open from lack of new branches, if pruning to encourage branching and to maintain vegetative vigor is neglected. A few varieties are inclined to produce their new shoots by an outgrowth of the tips of branches rather than from spurs or the production of new branches. This tends to keep the tree open, and heading back to induce the growth of the desired number of branches is often necessary. Varieties in which this characteristic is prominent include the Sergeant, Clyman, California Blue, and Sugar.

The health or thrift of the tree and the conditions under which it is growing, whether favorable or otherwise, are indicated by the new growth made during the current season, as is also the tendency toward fruitfulness. New shoots that make a strong growth may be headed back less severely than weak, slender ones and a larger crop of fruit of good size produced, provided good cultural conditions are maintained. If the tree is severely headed back each year, it is burdened with the production of a new crop of wood as well as with that of fruit. The danger of too little pruning lies in reducing the vegetative vigor of the tree to a point below that needed for the production of large fruit. If the season's wood growth is short it indicates drought, other unfavorable growing conditions, or insufficient pruning; and small fruit may be expected if the trees are allowed to bear even moderately heavy crops. Also, a much smaller number of lateral twigs will be produced by the varieties which normally produce spurs. Under the same conditions the trees which bear their fruit on twigs will come to production more promptly than those making a heavy growth.

If the current year's shoots which develop near the point of heading back are comparatively short, stout, and rigid, it indicates that the tree will be more open, will produce fewer fruiting branches, and will bear its fruit on spurs or short spurlike twigs. If the new shoots are long and slender, as they are on the Beauty and Santa Rosa, a thrifty wood growth is needed to enable the tree to produce large-sized fruit, and the tree is inclined to become compact and respond quickly to either favorable or adverse growing conditions. These rapidly growing shoots often branch during their current season's growth. Several of these branches, which often grow to considerable length, sometimes appear on a single shoot and cause the tree top to become very compact and shade the lower portion. This branching indicates that the shoots on which they grow will not produce heavy crops as promptly as shorter, stouter, unbranched ones. By removing the large shoots and the small, the slender, and the more frail ones, leaving the stoutest of those of medium length

and cutting these back sufficiently to insure the desired new wood growth, spurs and twigs should develop promptly.

With a few varieties the large vigorous shoots growing from stubs of branches of thrifty trees which were severely headed back send out short and slender but strong twigs along the lower part of the shoots during their first summer's growth. These twigs appear early in the summer and grow at right angles to the main shoot. They produce fruit at leafless nodes along much of their length when one year old, but spurs are produced at a few nodes near the end. Such twigs make but little length growth after their first season, but their spurs are prolific and long lived and retain vigor well even in moderate shade. Their appearance on new shoots indicates that the tree is thrifty and is inclined to bear its fruit on spurs instead of twigs. As these twigs appear well down along the shoots and remain prolific for a period of years, they should be spared and given light, and care should be taken that they are not broken during cultural operations. This type of growth is common with only a few varieties and these are in the domestica group. The President furnishes the best example (see pl. 32, B). In the Japanese group the Duarte is similar to the President in regard to the branching of the current season's shoots, but with the Duarte the twigs appear at somewhat less than a right angle to the parent branch, are slender and become drooping after bearing fruit, but are vigorous and continue fruitful for a number of years (see pl. 8, A). Trees below normal in vigor or those growing under unfavorable conditions and those not headed back in pruning seldom produce this type of twig.

Short right-angled spurlike twigs sometimes appear also near the tip of shoots during their current season's growth if the growth of the tree is checked by drought, the attack of insects, or otherwise.

Shoots which make a long, vigorous, whiplike growth start, for the most part, near a cut made in pruning, along the main limbs, and at the highest point of bending branches. The number of these shoots and the extent of growth made vary decidedly with the variety and with treatments which influence wood growth, the principal one of which is pruning. On 1-year-old wood which has been headed back, the growth of new shoots is, to a large degree, proportionate to the severity of the pruning. With some varieties the vegetative vigor appears to be very largely centered in the stubs of headed-back branches and almost all new shoots appear there. With other varieties given the same treatment the appearance of new shoots is distributed more or less throughout the tree. Trees of varieties which produce stout lateral spurs along the branch, but make only a few twigs and fruiting branches and remain open, are inclined to produce their new shoots near the ends of stubs of branches which have been headed back or near where branches have been removed. With those more inclined to produce twigs, new growth often appears along the older branches as well as on stubs of headed-back branches. Gaviota, Beauty, Tragedy, and Santa Rosa belong to the latter group, and Sergeant, Formosa, President, and Peach to the former.

If the trees have been pruned lightly or not at all and the soil moisture is somewhat below their needs there will be but a small extent of new wood growth, and the upper branches of open-grow-

ing trees which produce spurs will often lose their vigor earlier than those more inclined to produce twigs. Also, the new shoots which appear are often well down on the older wood. On the upper branches of such trees the fruit as well as wood and leaf growth is usually small. Under similar conditions, trees which produce twigs instead of spurs are inclined to retain their vigor better, although the twigs are not much longer than spurs. If growing conditions are favorable, some twig growth will take place at the terminals of some of the spurs of the spur-forming varieties, even where little or no pruning has been done.

Trees of varieties which are decidedly inclined to produce twigs rather than spurs, of which Giant, Agen, and Italian Prune are typical, continue to form new twigs from nodes of 1-year-old wood and to extend the terminal growth of twigs throughout the tree even where not pruned, if other conditions favor wood growth. By cutting back in pruning, the length growth of the twigs is greatly increased, and but few of them remain as short spurlike twigs, such as are found on unpruned trees. On trees which tend to produce twigs, the twigs appear principally at nodes of 1-year-old wood, but with trees of the spur-forming groups, any twigs which appear are usually the terminal outgrowth of spurs and seldom grow from 1-year-old branches unless these branches have been cut back. Few twigs are produced on most trees of the latter varieties, unless they are cut back in pruning or unless the crop is light. With a number of Japanese varieties, many long, slender twigs appear as an outgrowth of spurs, if the trees are severely cut back, the soil fertile, and moisture plentiful.

With spur-forming varieties the setting of spurs and their vigor and long life should be encouraged. Much toward this end may be accomplished in pruning by the thinning or heading back of branches, or both, to suit the needs of the variety and the individual tree. With such varieties excessive heading back may result in the loss of spurs in the interior of the tree through injury from shade caused by the dense new tops or by the outgrowth of spurs and twigs that follow such pruning. Too light pruning of such varieties may result in but little growth of the framework branches and in small fruit. Light pruning of varieties inclined to produce twigs instead of spurs may cause but a short growth of twigs and the formation of but few new ones.

The spurs of some Japanese sorts, of which the Apple variety is an example, are slender and brittle, and many of those on which twigs are being produced are broken during the fruit harvest and by strong winds. Spurs of the Japanese variety Formosa and of most domestica varieties, which increase in length considerably from year to year, become much strengthened as twigs grow from them, and they do not break as easily as those which grow slowly and remain slender.

If the vegetative vigor of the spur is low, as is often the case with compact trees of some Japanese varieties such as Beauty and Santa Rosa, twigs often spring from the branch at the base of the spur instead of from the spur itself. If these twigs are not well thinned out, the tree soon becomes compact and the fruit spurs in that part of the tree are lost (see pl. 12, A).

PLUM TREES BEFORE AND AFTER PRUNING

A.—A California Blue plum tree growing in an unirrigated section, before pruning. This tree is severely headed back and thinned out each winter, to maintain vigor and insure large fruit. (Compare with B)

B.—The same tree shown in A, after the annual pruning under the system followed to insure vegetative vigor and large fruit

C.—A 6-year-old Duarte plum tree growing in fertile irrigated soil, before pruning. This tree has been severely headed back each winter

D.—The same tree shown in C. The severe type of annual pruning here illustrated is often practiced to prevent the tree from growing too tall and to admit light. However, a rank growth of branches follows and insures large fruit. Dense shade in the interior of the tree results by early summer

RESPONSE OF DIFFERENT PLUM TREES TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—I

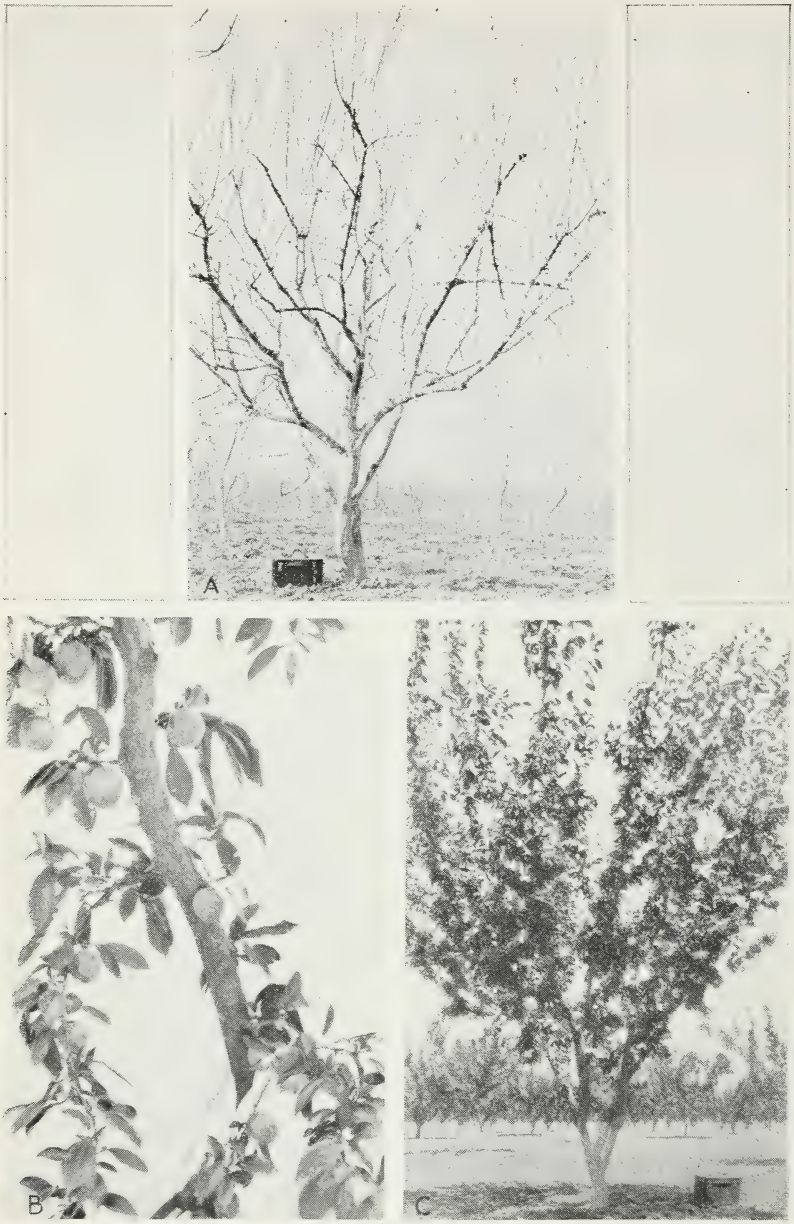
A.—Fruiting branch of the Imperial Epineuse plum: *a*, Twigs; *b*, spurlike twigs; *c*, spurs
B.—A 16-year-old Kelsey plum tree growing in the cool coastal region of California. This tree has been severely headed back each year and is growing in fertile irrigated soil. Note the very short annual growth and barren branches. (Niles, Calif., July, 1924)
C.—A 16-year-old Gaviota plum tree growing in the cool coastal region of California. This tree has been severely headed back each year and is growing in fertile irrigated soil. Note very short annual growth and barren branches. (Compare with pl. 10, A. Niles, Calif., June 29, 1923)

RESPONSE OF DIFFERENT PLUM TREES TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—II

A.—A 16-year-old Maynard plum tree growing in the cool coastal region of California. This tree has been severely headed back each year and is growing in fertile irrigated soil. Note the vigorous growth and compact tree. (Compare with pl. 2, B and C. Niles, Calif., June 29, 1923)

B.—An 18-year-old Grand Duke plum tree growing in the cool coastal region of California. It has been severely headed back each winter. The new growth is short, although the soil is fertile and irrigated. (Compare with pl. 20, B. Niles, Calif., July 9, 1924)

C.—A 16-year-old Washington plum tree which has been severely headed back each year. It is growing in fertile irrigated soil in the cool coastal region of California. Note the vigorous, compact growth. (Compare with pls. 20 B, and 34 B. Niles, Calif., June 29, 1923)

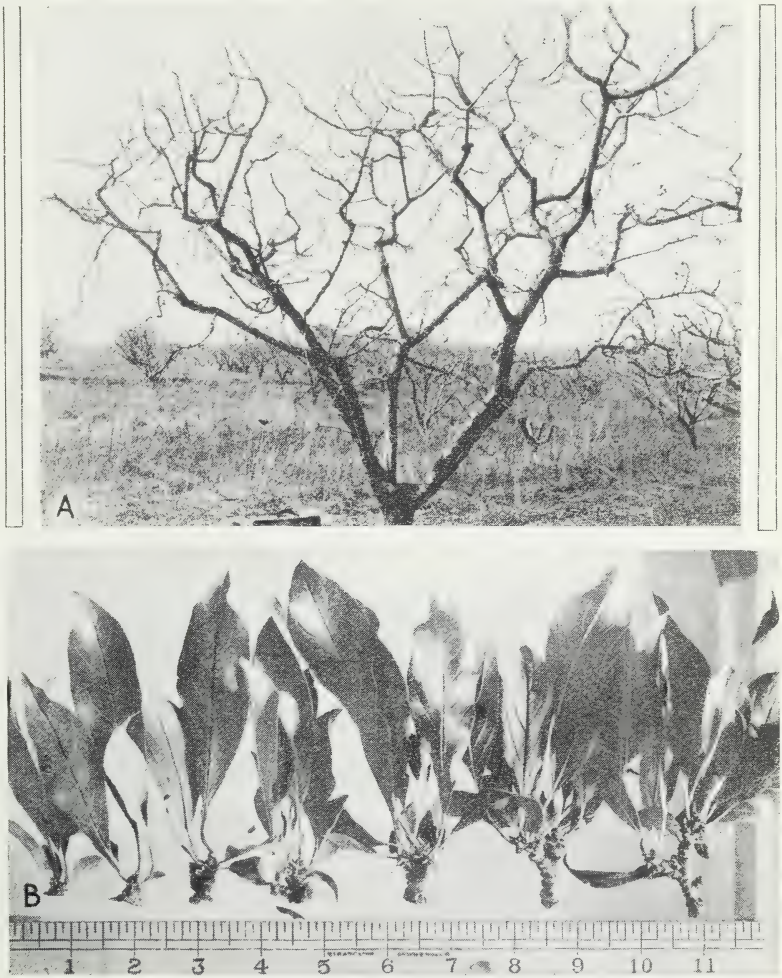


GROWTH AND FRUITING HABITS OF THE BEAUTY PLUM UNDER DIFFERENT SOIL AND OTHER CONDITIONS

A.—An old tree which has been headed back and thinned out each year, on deep, fertile, well-irrigated land, showing fruiting twigs throughout the tree. Most of the new shoots will be removed and the remainder headed back in pruning. (Courtland, Calif., January, 1924)

B.—Fruiting twigs and spurs. These form on branches of vigorous, well-opened trees if conditions are favorable to wood growth

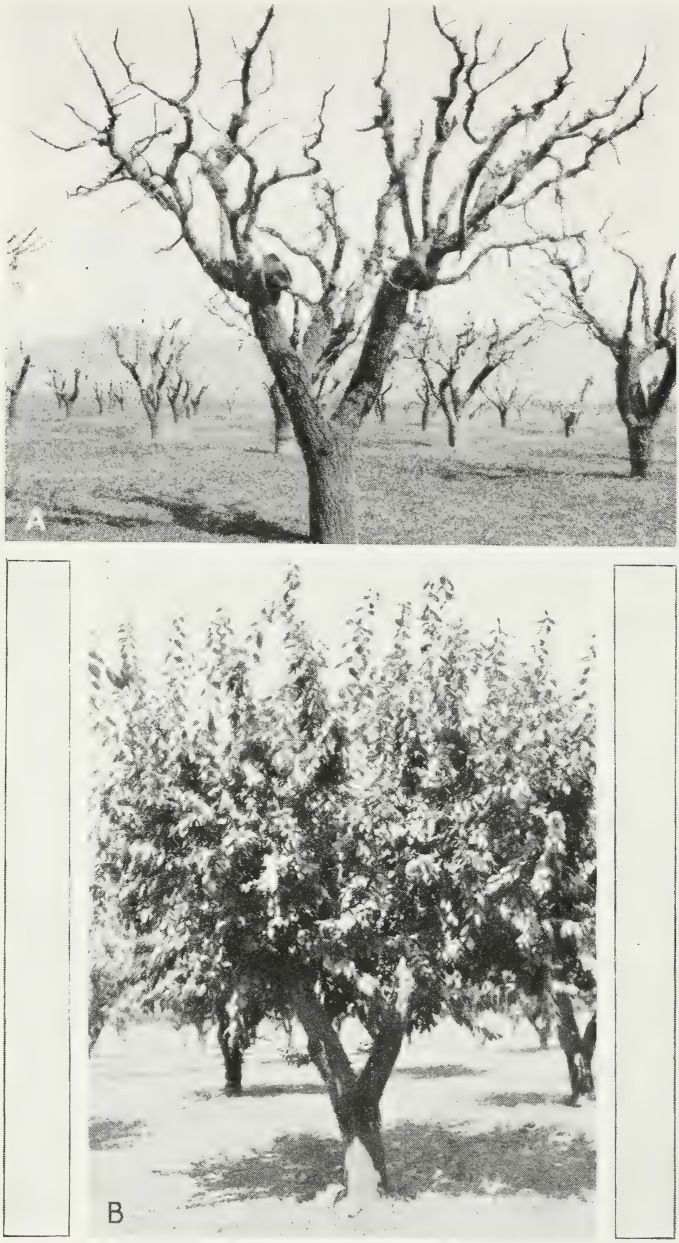
C.—Tree showing growth of twigs and spurs. This tree has been headed back and thinned out in winter and the new shoots thinned out each year about the 20th of May. This tree is not under irrigation. Vigorous twigs and spurs are formed throughout the tree. (Vacaville, Calif., July 7, 1923)



GROWTH, FRUITING HABITS, AND FRUIT SPURS OF THE BURBANK PLUM

A.—Tree which has been headed back each year, growing in fertile irrigated soil. Note the numerous fruiting branches, twigs, and spurs on the newer wood

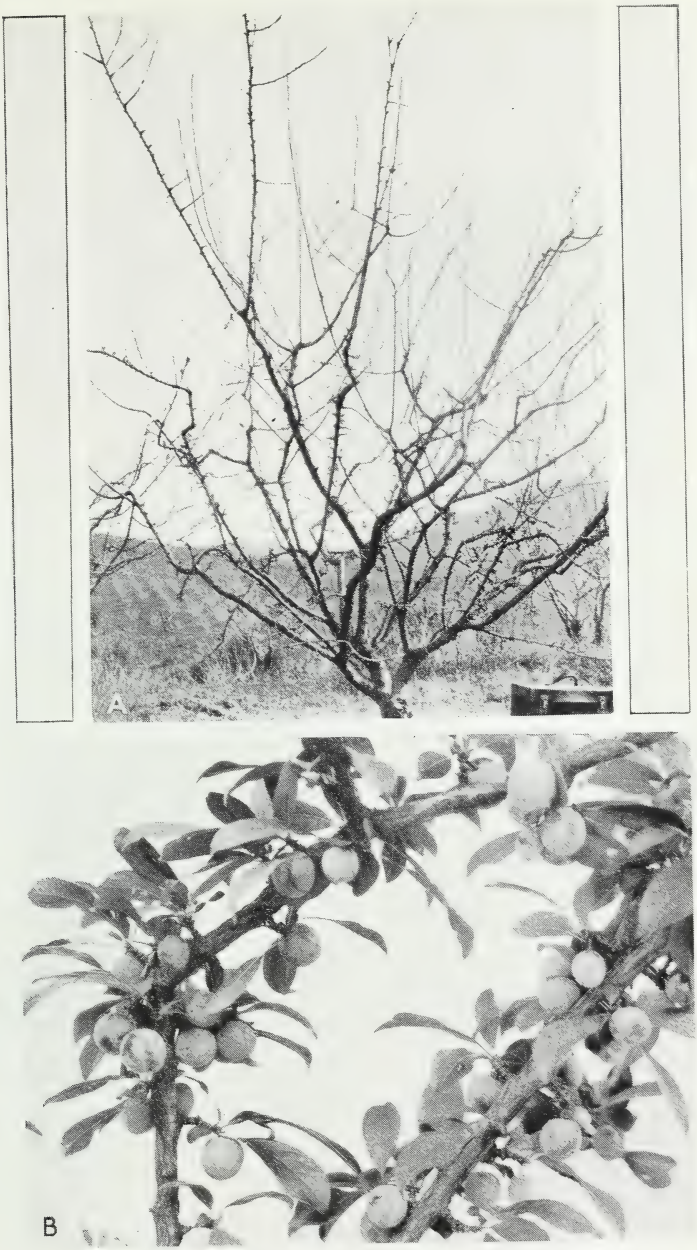
B.—Fruit spurs ranging from 1 to 7 years of age from an irrigated tree which has been moderately headed back and thinned out each year



GROWTH AND FRUITING HABITS OF THE BURBANK PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—I

A.—Old Burbank plum grafts, topworked on apricot, after a severe annual pruning. Almost the entire crop of fruit is borne on twigs 1 and 2 years old. The tree is growing in deep unirrigated soil where severe pruning is often necessary to insure large fruit. (Vacaville, Calif, February, 1923)

B.—The same tree shown in A, the following summer. The new growth is very vigorous, but too compact for the growth of spurs in the interior of the tree. (Vacaville, Calif., June, 1923)



GROWTH AND FRUITING HABITS OF THE BURBANK PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—II

A.—A 10-year-old tree which has been well thinned out each year in pruning but only lightly headed back. Note the vigorous spurs throughout the tree. The soil is fertile and under irrigation, and only moderate pruning is required. The tree has not as yet received its annual pruning. (Newcastle, Calif.)

B.—An 8-year-old fruiting branch of the Burbank plum tree shown above, showing the fruiting habit of old spurs

GROWTH AND FRUITING HABITS OF THE DUARTE PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Very vigorous shoots of the current season, growing on a thrifty tree which was severely headed back the previous winter. Note the growth of lateral twigs. (Compare with C and also with pl. 1, C. Newcastle, Calif., May 5, 1923)

B.—Fruiting twigs and thin spurs on framework branches 5 and 6 years old. The twigs were produced the same summer as the branches on which they grew. The tree has been headed back each winter and is in fertile irrigated soil. (Compare with A. Newcastle, Calif.)

C.—A few 4-year-old fruiting twigs which were produced during the first season's growth of the large branch. (Compare with A and B)

D.—A vigorous branch of a tree which has been pruned by heading back to lateral branches. Numerous spurs but only a few twigs have been formed. (Compare with A)

GROWTH AND FRUITING HABITS OF THE FORMOSA PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A tree which has been moderately headed back and the branches thinned out each winter. Note that the fruit spurs have been retained throughout the tree. It is not under irrigation and is growing in fertile soil

B.—Some 8-year-old branches on which the new shoots have been severely headed back each year. Note the long growth and but little branching of spurs. The tree is growing in fertile soil that has not been irrigated. (Vacaville, Calif.)

C.—Two 3-year-old branches which have not been headed back. The tree is growing in fertile irrigated soil. (Newcastle, Calif.)

D.—A 7-year-old branch of an open, vigorously growing tree. Note the long persistent spurs. The tree has been moderately headed back and the shoots thinned out each year. It is growing in fertile irrigated soil

E.—An 8-year-old tree which has been severely headed back each winter. The tree is growing in fertile irrigated soil. Note the heavy growth of new shoots. (Newcastle, Calif.)

GROWTH, SPURS, AND FRUITING HABITS OF THE GAVIOTA PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A thrifty tree which has been moderately headed back and thinned out each winter. There is a thrifty growth of foliage, spurs, and twigs, but only a few large new shoots. The tree under this treatment is inclined to remain open. The soil is fertile and irrigated. (Compare with pl. 2, C. Newcastle, Calif., July 3, 1919)

B.—Branch of a 9-year-old tree which has not been headed back but has been lightly thinned each year. Note the persistence of old spurs and that few of them have grown to twigs. (Compare with D. The trees in the two figures are growing in the same type of soil in the same locality, and both are under irrigation)

C.—Spurs from vigorous irrigated trees which have been moderately thinned out and headed back each year

D.—Twigs growing from spurs along framework branches of a tree which has been headed back and thinned to admit light each year. The vigorous growth shown is due to the fertile soil, irrigation, and pruning

E.—Branch of a tree which has been moderately headed back and the branches thinned out each year, showing production on old spurs

GROWTH, SPURS, AND FRUITING HABITS OF THE SANTA ROSA PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—I

A.—A tree which has been moderately cut back and thinned out each winter. It is growing in deep irrigated soil. (Photographed before annual pruning. Courtland, Calif., January, 1924)

B.—Some 1-year-old branches, showing habit of producing spurs at almost all nodes on larger shoots and of bearing fruit at nodes where spurs are forming. The more slender shoots produce fewer spurs along the basal segment and here produce fruit at leafless nodes

C.—Spurs (above) from a tree which has been well thinned out and moderately cut back each year and (below) from a tree which has been heavily headed back each year but only lightly thinned out

GROWTH, SPURS, AND FRUITING HABITS OF THE SANTA ROSA PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—II

A.—A tree which has been severely headed back each year. Shade from the dense new tops has caused the loss of spurs on the lower branches of the tree. (Compare with B. Newcastle, Calif.)

B.—A tree which has been well thinned out each year and only lightly headed back. Note that spurs have been retained well down on the older wood. The tree is in fertile irrigated soil. (Newcastle, Calif.)

C.—An 8-year-old secondary branch of a tree which has been kept open by annual thinning out. Note the thrifty spurs and twigs

DEVELOPMENT OF SPURS, TWIGS, AND FRUITING WOOD OF THE SATSUMA PLUM

A.—Branch from a vigorous tree, showing spurs and twigs on wood 1 and 2 years old. These live and remain productive for years if given light and the tree is kept thrifty. (Compare with pl. 13, B. Courtland, Calif.)

B.—A 25-year-old secondary branch of a thrifty tree, showing the persistence of twigs and spurs. (Courtland, Calif.)

C.—A 16-year-old tree which has been severely headed back each winter. Note the abundance of fruiting wood in all parts of the tree

GROWTH AND FRUITING HABITS OF THE WICKSON PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A 12-year-old tree which has been moderately headed back each year and kept open so that the spurs have not been killed by shade or induced to grow to twigs such as those of most trees severely pruned and irrigated. The soil here is fertile but not under irrigation. (Vacaville, Calif., June, 1923)

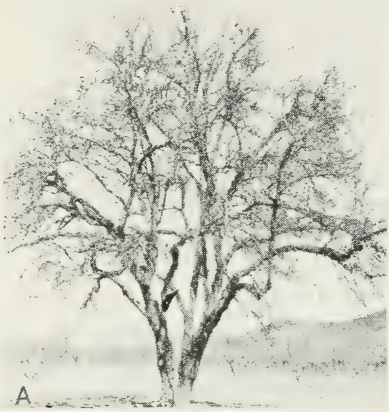
B.—Fruiting twigs showing fruiting spurs and cutting back which has been practiced in pruning to maintain vigor

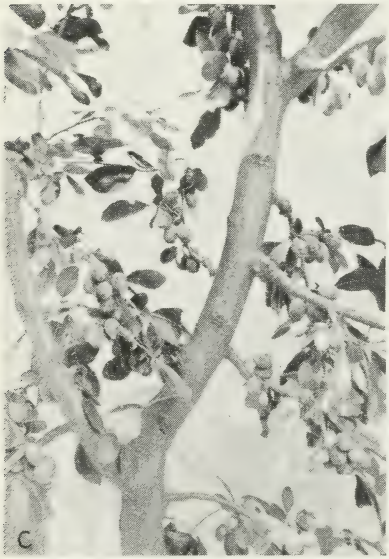
C.—An old tree growing in fertile unirrigated land. The new growth has been severely headed back each winter. Note the short growth of shoots and barren framework and secondary branches

RESPONSE OF THE WICKSON PLUM TREE TO MODERATE PRUNING

A.—Branches from an irrigated tree which has not been pruned for 15 years. Note the lack of new shoots and twigs, but the very numerous old spurs. (Newcastle, Calif.)

B.—An old tree in fertile irrigated soil which has been moderately headed back and thinned out each year. Photographed after pruning. Note the numerous spurs and vigorous twigs. (Newcastle, Calif.)





GROWTH, FRUIT SPURS, AND FRUITING HABITS OF THE AGEN PRUNE IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A thrifty old tree which has not been pruned recently and is not irrigated. This tree produces heavy crops of medium-sized fruit. Thinning out of fruiting branches is needed to increase the size of the fruit. (Vacaville, Calif.)

B.—A 10-year-old tree. The short spurlike growth instead of longer twigs indicates lack of thrift, although the tree is in fertile irrigated soil

C.—Framework branch of the tree shown in D, indicating the fruiting habits of a tree on which all shoots and young twigs have been severely headed back each winter

D.—A 16-year-old tree which has been severely headed back each year and is growing in fertile irrigated soil. It is very vigorous and produces heavy crops of fruit. (Niles, Calif.)

FRUITING HABITS IN RELATION TO GROWTH

For the purpose of studying fruiting habits of plum trees in relation to the portion of the tree on which the fruit is borne, the varieties grown commercially are considered under two groups, the Japanese and the domestica.

In the Japanese group, fruit is borne both at nodes on 1-year-old wood and on spurs throughout the tree. It is found on spurs with leaves or at nodes of 1-year-old wood where spurs are forming, except that shaded or crowded spurs sometimes set fruit but fail to produce leaves and die after the fruit ripens. Some leafless nodes of slender, crowded, 1-year-old twigs also bear fruit. As with varieties of the domestica group, little, if any, fruit is borne on large 1-year shoots which develop on branches which were headed back or on water sprouts lower in the tree. On the 1-year-old wood, the crop is often heaviest on the shorter, more slender wood; and in many cases the fruit on such wood is not of profitable size and market quality unless both fruiting branches and fruit are well thinned.

Many varieties of the domestica group bear much of their fruit at leafless nodes of 1-year-old wood. Most of these varieties bear only an occasional fruit, if any, at a node where a spur or twig is forming. The California Blue is one of the exceptions to this. Leafless nodes which bear fruit remain barren after the fruit ripens, and varieties of the twig-forming type often require new twigs each year to provide fruiting wood for the following season. A few domestica varieties produce spurs instead of twigs, and with these the crop is produced largely on spurs. If for lack of moisture or other causes the wood growth on such trees was short the previous year, fruit production will often be heavy on the 1-year-old wood, as with twig-forming varieties, and be produced almost entirely at leafless nodes. A short portion of the 1-year-old wood on such trees is barren of both fruit and leaves; and as the upper end of the branch produces no fruit, there is a proportionately long segment which bears fruit at leafless nodes and remains barren thereafter. This leaves but a small segment of the twig to produce fruit the following season. On such trees, many of the spurs which form are short and produce heavily when 1 year old and die after harvest. To provide more fruiting wood for such trees, it is necessary to alter growing conditions or adopt a pruning method which will induce a more vigorous wood growth.

HABITS OF GROWTH OF FRUIT SPURS

Fruit spurs of most varieties may be placed in one of two classes: (1) Those of the rosette type, or those which are inclined to end in a cluster of short, compact branches; and (2) those inclined to become considerably lengthened by the outgrowth of the terminal bud of the spur leader. The Burbank, Gaviota, and Duarte furnish illustrations of the former and the Formosa and California Blue of the latter (see pl. 5, B; pl. 9, D; pl. 10, C; and pl. 17, D). Most Japanese sorts and their hybrids fall within the first group, the Formosa being a decided exception. In the second class are included many of

the domestica varieties, although in these varieties there is considerable divergence in the extent of growth and manner of performance of the spurs. Some varieties, including the Giant, Grand Duke, Pond, Washington, and Yellow Egg, produce few typical fruit spurs if the twig is sufficiently vigorous to make a thrifty new growth and to produce large-sized fruit, as all new growth forms twigs or dies after bearing fruit. In another group of domestica varieties, including the Imperial Epineuse, President, Sergeant, Clyman, and Jefferson, the spurs make but little terminal growth but often branch freely and remain vigorous over a period of years. The Tragedy may be included in this group also, though a tendency to produce both twigs and spurs is more characteristic of this variety than of any other.

The behavior of the Sweetheart, a little-known variety, illustrates a tendency distinct from those just mentioned in that numerous short, thrifty twigs grow from the framework and fruiting branches, and on these grow numerous lateral twiglike spurs (see pl. 39, C). This fruiting wood remains thrifty for a number of years, although but little annual growth is made by either the main twig or its lateral branches when compared with the twig growth of typically twig-forming varieties. The growth is longer, however, than that of spurs on spur-forming varieties.

The Japanese varieties and those derived from them are inclined to produce spurs and retain them over a considerable period of years, whereas with the domestica varieties the spur-producing tendency differs decidedly and the spur development is greatly influenced by cultural and climatic conditions. If conditions are unfavorable for wood growth, the varieties of the domestica group, which are inclined to produce twigs, develop spurs instead, through the failure of the twigs to make their normal length growth, although the twigs which have terminated in spurs will continue their length growth when favorable growing conditions recur. Those varieties which produce both twigs and spurs, such as the Tragedy, produce only spurs under unfavorable conditions; but the President, a spur-producing variety, will develop fewer than the normal number of spurs under unfavorable growing conditions, and many of those which are formed die after producing fruit (see pl. 31, D, and pl. 37, B).

The varieties which normally produce spurs, rather than twigs, form the spurs along the greater part of the length of all 1-year-old branches except on the small slender shoots and a segment at the base of the large shoots. Where, on account of the lack of soil moisture or for other causes, trees of the domestica group make little growth and all new shoots are small, few, if any, spurs are formed along them. This result is much less striking with varieties of the Japanese group. With the domestica varieties where the conditions for wood growth are unfavorable and the new shoots are short, fruit is borne at almost all nodes of the 1-year-old wood except near the tip, and spurs are rarely produced at the fruiting nodes (see pl. 32, A). This leaves the fruiting nodes barren after the fruit ripens. On the whole, a greater portion of the crop is borne on 1-year-old wood in the domestica group than in the Japanese, since many domestica varieties produce most of their fruit on this wood; but the

tendency to form spurs is stronger with the Japanese group, and the production of spurs at fruiting nodes is more common.

The number of years during which spurs live and continue to fruit varies greatly with the variety and with the environment. In general, the Japanese varieties retain spurs longer than the domestica; but within each of these groups, and more especially in the domestica, there is a wide difference among the varieties as to the performance of the spurs. If not weakened by shade or excessive crops, spurs of most Japanese varieties remain thrifty and productive for several years. The Burbank and Formosa are examples of Japanese varieties which retain their spurs well down along the old wood (see pl. 7, B, and pl. 9, D). With the former this is due to the fact that the tree is naturally spreading and therefore admits light to the interior of the tree, unless pruning to induce a compact top is practiced. The trees of the latter, although naturally upright, branch but little and tend to remain open. Other Japanese varieties, including the Santa Rosa and Beauty, make a compact, erect top growth if the trees have been headed back in pruning. The shade in the interior of the tree results in slender spurs, many of which are short lived. If these trees are kept open to admit light the spurs are retained well. Trees of some other varieties, of which Duarte and Eldorado are examples, send out slender branches freely at a wide angle to the main branch during their first or second season's growth. These slender branches produce many spurs and retain them well, as they withstand more shade than those on most other trees where the new growth is naturally upright.

Of the domestica group, the varieties which are distinctly spur forming, such as the Jefferson, Sergeant, Imperial Epineuse, President, and California Blue, retain their spurs over a long period (see pl. 17, D; pl. 26, A; and pl. 31, A). The spurs are prolific and withstand shade rather well. Because of the naturally open growth of spur-producing trees they are usually well supplied with light. Varieties which produce twigs rather than spurs often lose any spurs which are produced after a very few years, at most, if the trees are making a thrifty growth. They soon grow to twigs if not fruiting, and fruiting spurs often die after the fruit harvest if they do not grow to twigs the same season (see pl. 25, C). Many trees of the twig-forming type produce fruit heavily on 1-year-old spurs. Very few of these fruiting spurs produce leaves, and they die after the fruit ripens. Spurs on such trees are easily injured by shade, and many of them are lost from this cause, as the growth of twigs and branches usually results in a compact tree if a thrifty wood growth is maintained. With some varieties, notably Golden Drop and President, the tendency is for the spurs to be short lived if the annual growth is poor. On such trees the 1-year-old twigs and spurs are very prolific, and after the fruit ripens many of the 1-year shoots are left barren and many 1-year spurs lost. If the trees grow vigorously the shoots are large and fruitfulness is somewhat delayed, permitting the formation of a greater number of spurs, which become well established on the new wood (see pl. 31, A).

Unfavorable growing conditions are indicated if spurs form at the end of twigs of varieties which are inclined to produce twigs instead of spurs, and it is only by the improvement of growing con-

ditions of such varieties that regular and good crops of large-sized fruit from them may be expected. Drought and insufficient pruning are the usual causes for this type of growth, although poor soil or root or branch diseases (pl. 37, B) may give similar results. It is encouraged also by little or no cutting back of the new wood in pruning and hastened by heavy fruit production.

If trees normally spur bearing produce more twigs than are desired, the excessive growth may be corrected by substituting thinning of branches for cutting them back in pruning. If spurs are inclined to grow to twigs readily, as they do on the Tragedy, Imperial Epineuse, and Sergeant under favorable growing conditions, less cutting back and more thinning out to admit light is needed than where the new growth is normally short, as is the case with the Jefferson.

Where spurs are lost from excessive shading, some time will be required in corrective pruning to establish new ones, since as a rule it is desirable to establish new shoots and twigs on which spurs are to develop. If the trees have been kept low, the outer shoots may serve for the fruiting wood and be induced to develop spurs if enough of them are eliminated at pruning time to admit the necessary light; but for taller trees, heading back and removing enough old branches to induce new shoots to spring from the old wood are necessary. In such cases it is well to establish fruiting wood nearer the ground.

Some varieties retain the vegetative vigor of the old wood much better than others, and such varieties are most inclined to develop new spurs on old wood. With these, less heading back is necessary to induce new growth. In general, the Japanese varieties replace spurs which have been broken off or those lost by natural causes much better than the domestica, although there is a decided variation among Japanese varieties in this respect. Those which produce short fruiting twigs most freely by the outgrowth of spurs also renew lost spurs on old wood more readily when favorable conditions for spur development recur. Trees of varieties on which the main branches send out numerous long, slender twigs, along which most of the spurs of the trees are formed, do not replace lost spurs readily; and cutting back in pruning or other changes in treatment sufficient to cause the growth of new branches and twigs is needed. The Duarte, Eldorado, and Santa Rosa are the best examples of those which produce many long, slender twigs and on which spurs tend to remain small and do not grow to twigs. The Satsuma and Gaviota are perhaps the best examples of those whose twigs grow readily from spurs.

In the domestica group the variation in regard to the growth of twigs from spurs is more pronounced than in the Japanese group; although, in the former, varieties most inclined to send out twig growth from the spurs are also most inclined to replace injured spurs (see pl. 17, C). The Imperial Epineuse, Sergeant, and California Blue illustrate this. With other typically spur-bearing varieties where little, if any, twig growth appears on the spur unless some living wood has been cut back or removed in pruning, spurs broken off are seldom replaced (see pl. 23, D, and pl. 29, C). Jefferson

and Golden Drop are examples of this type. Such open trees usually retain spurs well, however, and seldom lack for fruiting wood. Golden Drop is to a certain extent an exception to the latter rule.

The branches of domestica varieties which are decidedly twig bearing soon become barren by the dying out of twigs if conditions are unfavorable for wood growth (see pl. 19, C). In such places heading back to induce the growth of new shoots from which twigs may grow is necessary, as fruiting twigs do not grow freely from the older portion of the branch.

EFFECT OF LOW SUMMER TEMPERATURES ON WOOD GROWTH

In the group of Japanese plums and their derivatives a decided difference in thrift and habits of growth has been observed with different varieties growing in the cool, coastal region of California. With certain varieties, differences in thrift are noticed also between trees growing in the cool region and those of the same variety growing in the interior valleys of California where the summer temperatures are high. Trees which have had their new growth severely and regularly headed back in winter and are growing in fertile irrigated soil have been used for comparison.

In the region near Niles, Calif., the cool breezes from the San Francisco Bay maintain a temperature several degrees below that near Auburn or Vacaville, two of the important plum-growing sections in the interior valleys of California. (Table 1.) In the cooler region the vegetative vigor of a few varieties is decidedly lower than that of others. With these varieties the new shoots growing from the previous year's shoots which have been headed back are slender and short and often reach but a few inches in length even in the tops of the trees; the spurs make but little terminal growth; new twigs which appear are slender; and spurs and twigs which are broken off or die are seldom replaced. Varieties which illustrate these weaknesses include Occident, Kelsey, Chalco, Gaviota, and Wickson (pl. 2, B and C). There is considerable variation, however, among these varieties, their comparative weakness being in the order named. These varieties contrast with Maynard, Santa Rosa, Burbank, Satsuma, and Apple, which make a very thrifty growth (pl. 3, A). Occident, Kelsey, and Chalco are inclined to lose their spurs and twigs early and the portion of the branch which is but a few years old becomes barren and remains so. The spurs of Gaviota also are inclined to die out early, but the twigs are moderately persistent and fairly thrifty. The spurs of the Wickson live and remain productive along the entire branch of even the framework branches, although they make but little lateral growth. Twigs and new shoots such as grow from branches that have been headed back are very short. Vigorous shoots have been observed growing from framework branches of trees of this variety, but the vigor of the smaller fruiting branches is low.

In the interior valleys, where the maximum and mean temperatures during the summer months are decidedly higher than in the coastal region, all varieties of the Japanese group which have been observed grow well.

TABLE 1.—*Maximum, minimum, and mean temperatures, May to September, inclusive, for cool and warm plum-producing districts in California*

[Data for cool and warm plum-producing sections, from the summaries of climatological data for the United States by sections for the different stations of the Weather Bureau, as follows: *A*, UNITED STATES DEPARTMENT OF AGRICULTURE, WEATHER BUREAU. SUMMARY OF THE CLIMATOLOGICAL DATA FOR THE UNITED STATES, BY SECTIONS. REPRINT OF SECTION 14.—CENTRAL AND SOUTHERN CALIFORNIA, p. 23, 1925. *B*, UNITED STATES DEPARTMENT OF AGRICULTURE, WEATHER BUREAU. SUMMARY OF THE CLIMATOLOGICAL DATA FOR THE UNITED STATES, BY SECTIONS. REPRINT OF SECTION 15.—NORTHEASTERN CALIFORNIA, p. 36, 37, 1917.]

Stations		Temperatures (° F.)				
		May	June	July	August	September
Oakland (*A*)	Maximum	69.0	72.7	73.0	70.2	70.6
	Minimum	50.2	52.7	53.8	54.3	54.1
	Mean	58.1	61.5	61.8	61.3	61.2
Auburn (*B*)	Maximum	74.7	85.1	91.7	91.8	83.5
	Minimum	50.1	55.0	61.1	60.3	54.5
	Mean	62.7	70.8	76.8	75.9	71.0
Vacaville (*B*)	Maximum	78.5	84.1	93.5	92.1	86.4
	Minimum	48.6	51.7	55.8	55.6	52.5
	Mean	64.2	71.0	75.5	74.5	70.8

The difference in temperature of these regions has decidedly less effect on the vigor of the varieties of the domestica group than of the Japanese, although the vigor in the fruiting twigs has been observed to be notably less with the varieties Grand Duke and Diamond than with most others in the cooler region or when compared with trees of the same varieties in the warmer places (pl. 3, B, and 20, B). Washington and Sergeant illustrate domestica varieties which grow well in cool as well as warm sections (pl. 3, C, and 34, B).

HABITS OF GROWTH AND PRODUCTION OF SOME PLUM VARIETIES GROWN IN THE PACIFIC STATES

VARIETIES OF THE PRUNUS TRIFLORA GROUP AND ITS DERIVATIVES OR HYBRIDS

BEAUTY

Tree very vigorous, erect, branches very freely, and produces and retains fruit spurs and twigs in all parts (pl. 4, A).

The shoots which grow freely from cut-back tops and along fruiting branches and trunks of open trees make a rapid, slender, upright growth; and those on the outside of the tree or in open trees branch freely their first season. The new branches are slender, make an upright growth, and are often numerous, thus producing a compact top and dense shade lower in the tree. Slender twigs and longer shoots appear at the terminals of spurs and twigs throughout heavily pruned trees (pl. 4, B). When the tree is lightly pruned and other conditions are unfavorable for wood growth, spurs and twigs make little or no new wood, lose vigor, and produce small fruit. In unirrigated orchards the wood growth is decidedly less than in irrigated ones, and fewer large shoots and long fruiting twigs are produced, except in the tree top. Instead of the long slender branches and twigs which are found throughout the body of the tree in the irrigated orchard there are short twigs and spurs.

Spurs on this variety form in greater numbers than on almost any other, appearing at almost all nodes along the 1-year-old wood. In this the Beauty differs from the many varieties which bear heavily on 1-year-old wood but fail to produce spurs there. The spurs are slender, easily broken, branch freely in open places in the tree, are long lived and productive, and those bearing fruit are more inclined than those of most other varieties to produce a good crop of leaves. In shaded places and on trees which are growing

poorly they are often unbranched and are more slender and more easily broken than elsewhere. Under conditions favorable for wood growth, many spurs along the larger branches grow to twigs, and in this way and by being killed with shade from the dense tops, many spurs or twigs in the interior of the tree are lost if the tree has been regularly and heavily headed back. On such trees the development of new spurs may often be induced by removing branches to admit light, as the older wood retains its vigor well (pl. 4, C).

Fruit is borne on spurs of all ages throughout the tree and at nodes of 1-year-old twigs. Where the tree has been kept open and the crop is not excessive, almost all fruiting spurs produce leaves; and the fruit on 1-year-old twigs is usually at nodes where spurs are forming, which indicates the strong vegetative vigor of the variety.

This variety is very prolific and bears regularly, producing fruit in all parts of the tree. Unless twigs, branches, and fruit are well thinned out, the fruit will be small and much propping of branches will be necessary when the fruit approaches maturity. As branches are inclined to be slender, heavy crops cause them to bend and expose fruit to the sun; and as the fruit is easily sunburned, the loss from this cause is considerable, unless trees with strong rigid branches have been developed.

BURBANK

Tree open, spreading, very vigorous, branches freely, and forms numerous spurs which are retained over a period of years (pl. 5, A).

Spurs form at almost all nodes of 1-year-old shoots and twigs and, if not injured mechanically or by shade, remain thrifty and productive for many years. The spurs form many short branches but no decided leader, and they remain rather short, broad, and compact. Where light permits, they are heavily leaved and the leaves are long and large, indicating natural vigor (pl. 5, B). Heavily fruiting branches of the spurs sometimes die after harvest, and new ones rarely appear in their places. Where wood growth is considerably encouraged by pruning or where a part of the spur is removed, a branch of the spur will often grow to a slender twig. These twigs produce spurs and bear fruit well but usually remain short and slender. The basal portion of the spurs is very strong, but the branches of spurs break easily at the termination of a year's growth. Many branches of spurs and slender twigs which grow from old spurs are therefore broken by strong winds or through harvesting the fruit. If trees are thrifty and sufficiently open to admit the needed light, spurs which have been broken off are often replaced by new ones even along the older wood.

With this variety, as with others, heading back causes a rank growth of new shoots just below the point of pruning, and differing from most varieties these shoots radiate outward in all directions, forming an almost spherical tree top (pl. 6, A and B). If, in pruning, the tree is thinned out well each winter and only moderately or lightly headed back, fewer long shoots and slender twigs grow from spurs than in a heavily headed-back tree, and a greater proportion of the new growth is short and stocky. In this case the spurs are retained throughout the tree and are vigorous and productive (pl. 7, A). With no pruning, few new branches are produced, and these are usually short and frail if growing conditions are not above normal. The fruit is small and usually unprofitable on such trees.

Almost the entire crop of fruit is borne on spurs with leaves or at nodes of 1-year-old wood where spurs are developing. This shows a decided tendency to produce and retain spurs (pl. 6, A, and pl. 7, B). Considerable fruit develops on 1-year-old twigs and more on the large 1-year-old shoots than is common with most varieties. This, with the strong growing tendency, indicates the combined vegetative vigor and fruitfulness of this variety.

After a strong framework and numerous secondary and fruiting branches have been formed, the naturally open body of the tree should be kept well open and outer branches cut back and thinned moderately to maintain the needed vigor but not sufficiently to cause a compact tree. The removal of some of the more slender twigs, on which the fruit is often small, will not only admit light to the spurs below but prove an effective method of thinning the crop. By developing vigorous spurs throughout the body of the tree, regular crops of good-sized fruit may be expected.

The uniformity of growth and production under different temperatures and cultural conditions is more marked with the Burbank than with most other

commercially cultivated varieties. It may be contrasted with the Apple variety, which also belongs to the triflora group. The two varieties make a similar growth in the cooler coastal region; but in the hot interior valleys of California the Apple is inclined to produce only short, slender twigs, while little difference is noticed in the growing habits of the Burbank. Kelsey and Wickson, other Japanese varieties, are similar to the Burbank but unlike the Apple in that they grow well in the warm sections, but they show decidedly lower vegetative vigor than either in the cool regions.

CLIMAX

Tree spreading, rather open, vigorous; produces both twigs and spurs, although it is more inclined to produce spurs than twigs. The annual growth on trees which have been headed back is not as heavy as on those of most Japanese varieties which have had the same pruning treatment.

The new shoots develop mostly on the stubs of cut-back branches, although an occasional large shoot grows from an old branch and smaller shoots and twigs grow from terminals of branches and spurs. The new shoots are not as numerous nor as long as on some other Japanese varieties, but are more stocky. They often branch during their first summer's growth and are heavily leaved, so that after the branching there is often a dense shade in the interior of the tree. On trees severely headed back in winter most new shoots grow erect, although a number grow outward from the side of the tree. These laterally growing branches increase the breadth of the tree from year to year by the amount of them which is left after pruning. The new growth of lateral branches is greater on trees lightly pruned than on those severely pruned.

Trees regularly and severely pruned produce numerous twigs as well as large shoots. These grow from the terminals of branches, spurs, and twigs as laterals on the new shoots. On thrifty open trees a large number of them grow from spurs. Those which are produced on the new shoots are, for the most part, on the larger more stocky shoots and appear rather early in the season. The twigs are slender and as they fruit heavily they soon become drooping. If the tree is kept open the fruiting twigs live for a number of years, produce numerous spurs, and fruit well. As fruit of this variety sunburns rather easily, there is an advantage in having the fruiting twigs distributed along the older branches which do not bend readily with a load of fruit and where the fruit is protected by the outer branches. The pruning system which is followed in unirrigated orchards to insure a good wood growth and large fruit results in the growth of many twigs and therefore much fruiting wood.

Spurs form on almost all nodes of 1-year-old wood except near the base of the larger 1-year-old shoots, even at nodes of slender twigs where fruits have set. They are rather short, broad, branch but little, and are prolific. Large clusters of fruit often set on them. Few of them grow to twigs unless the tree is induced to make rather a vigorous growth by heading back or by thinning the branches. The spurs are sensitive to shade, and many of them are lost from this cause when they become 2 or 3 years old or older. Although trees of this variety are very decidedly of the spur-producing type, many of the spurs disappear if the tree is not kept open. The vegetative vigor of the branches is centered in the newer part of the branches much more with this than with most Japanese varieties, as is shown by the few shoots which appear along the older branches as contrasted with such varieties as Beauty and Santa Rosa and also by the early loss of spurs in the interior of trees which are producing a vigorous growth from the cut-back branches. Although severe heading back results in large fruit, it also causes an early loss of spurs if the tree is not kept open. If the tree is growing well and is kept open by the regular thinning of branches, many spurs remain thrifty and productive for a long period.

The fruit of this variety is borne both on spurs and at nodes of 1-year-old twigs. The twigs are very vigorous, as is indicated by the numerous spurs that are formed at nodes along them which are also bearing fruit. The 1-year-old spurs bear well, and some of these which bear fruit produce leaves also, if not in a shaded part of the tree, but many are leafless if fruiting and die before the following year. The 2-year-old and 3-year-old spurs manifest less vigor than the younger ones and less than is usually found in Japanese varieties. Many of these which bear fruit die after the harvest. This is more especially true if the trees are headed back at the annual pruning and are making a

vigorous growth. The declining vigor of spurs is more pronounced in coastal sections where summer temperatures are low than in the warm interior valleys of California.

DUARTE

Tree very vigorous, upright, inclined to branch freely but to make few framework and secondary branches and to produce numerous small branches and twigs. Spurs are produced in abundance and retained over long periods in parts of the tree which are kept open (see pl. 1, C).

Large shoots which become framework branches grow from stubs of branches which have been headed back, and along older branches near the point where branches have been removed, but seldom from unpruned parts of the tree. Like the smaller branches and twigs, they terminate in spurs, although they resume their terminal growth under conditions favoring wood growth. They make a rapid long growth if the trees are irrigated and the tops headed back, and early in the summer they send out numerous lateral twigs which vary in growth from a few inches to a foot or two in length (pl. 8, A).

The lateral fruiting twigs form on the current season's growth only, do not branch except to form fruiting spurs, remain slender and become drooping, increase in length when the season is favorable for wood growth, and their spurs are prolific over a period of years (pl. 8, B and C). Under poor growing conditions but few of these twigs develop, and they are short and slender. Vigorously growing trees with their heavy crop of fruiting twigs soon form dense tops which shade the fruiting spurs and branches below, and the fruiting wood in this part of the tree soon disappears. On small branches or on larger ones which are not headed back or are cut back to lateral branches only a few lateral twigs appear, but numerous vigorous spurs develop along all branches (pl. 8, D).

The fruit spurs are short, stout, and compact and are not easily broken from the branch. They develop at almost all nodes on both slender twigs and the larger branches where twigs have not developed. In the densely shaded portion of the tree the 1-year-old spurs are often leafless and die after fruiting, but those which become well established are very persistent and remain for many years if given light.

Fruit is borne, for the most part, on spurs with leaves and along twigs and larger branches extending well down on the old wood. Some fruit is found on 1-year twigs where spurs are forming and on leafless 1-year spurs along the lower portion of the larger 1-year shoots.

With its slender unbranched fruiting twigs and short, compact, persistent spurs this variety closely resembles the Eldorado in fruiting habits, except that the Eldorado produces its lateral fruiting twigs on 1-year-old wood, whereas with the Duarte they appear very early on the current season's growth. These fruiting spurs and twigs also resemble those of the Santa Rosa and Beauty, but these varieties are decidedly more inclined to branch and to form numerous secondary branches and therefore to become more compact than the Duarte.

FORMOSA

Tree upright, open, and vigorous, inclined to branch but little after reaching full bearing, to make but little terminal growth if branches are not cut back, and to produce and retain fruit spurs along the entire length of the branches (pl. 9, A).

The spurs branch only a little, but they add considerably to their length from year to year and reach a greater length than those of other varieties of the Japanese group. In this characteristic they resemble more the short-twig type of spur common in the domestica group than the rosette type most common in the Japanese group (pl. 9, B). They remain thrifty and productive for many years even along the old framework branches of the tree, but are often slender and are rather easily broken. If broken off they are seldom replaced by new ones. Few of the side branches of the spurs live more than a very few years, and many die after they bear one crop of fruit. This leaves fewer points of the spur for fruit production than is usual with other Japanese plums and makes fruit thinning easier and large sizes of fruit more probable.

When the branches are headed back the spurs increase more in length than otherwise, but seldom grow to twigs or branches, as do those of most other Jap-

anese varieties, except immediately below the point where a branch has been cut off. Along a portion of the branch just below where it was headed back a few spurs sometimes increase in length by a few inches, while those farther down respond but little to the pruning. If very severe heading back is practiced each year, so that only a few inches of the 1-year-old shoots remain, the long twiglike spurs constitute the main supply of fruiting wood. However, the building of the framework branches will be slow, and many years may be required to develop a tree of desirable size (pl. 9, B).

Where no pruning is done, spurs form at almost all terminals; and in this case the annual growth is short and the length growth of lateral spurs less than on pruned branches (pl. 9, C).

If open trees are left without pruning for a few years, the upper portions of the long slender branches often lose some of their vigor; and any new shoots which appear are along the main framework branches, indicating a proportionately lower vegetative vigor in the outer, unpruned branches.

Although the thrifty bearing tree is inclined to branch only when pruned and not to produce side twigs or branches, the persistence of fruiting spurs and their tendency to lengthen from year to year make fewer fruiting branches necessary than are found on most varieties, as each main branch becomes a large cylinder of fruiting wood (pl. 9, D). When conditions change to encourage wood growth, the resulting growth, in the case of trees not recently pruned, is more or less uniform on the terminals of spurs throughout the tree. The new growth here is rarely more than a very few inches in length.

If trees have been well irrigated and headed back, heavy rampant shoots, usually from two to four on each vigorous cut-back branch, appear immediately below the point of pruning; or, if the entire branches are removed, they appear along the remaining branch. These shoots produce large, spreading leaves, and if the headed-back branches are numerous a compact tree results (pl. 9, E). Here the spurs in the interior of the tree soon die, leaving only barren branches. In unirrigated orchards the new shoots are few in number and their growth short, and excessive shading is unlikely. Severe cutting back, however, is usually necessary to provide sufficient vegetative vigor for unirrigated trees.

Fruit is borne on spurs throughout the tree and on the smaller 1-year branches but rarely on the heavier 1-year-old wood. It is almost always at leafless nodes on both branch and spur, leaving these nodes barren after the fruit ripens.

The long, unbranched growth made by branches of young trees of this variety makes the problem of shaping the young tree an important one. Many framework branches with their proportionate slenderness soon result in the need for props after the tree comes to bearing; and the fruit is in danger of sunburning, on account of the bending of branches. By selecting a few well-spaced branches to form the main framework of the tree and cutting these back to induce branching at the desired points, a well-shaped tree may easily be developed.

GAVIOTA

Tree vigorous and upright spreading, inclined to make but few secondary branches, but produces many fruiting branches, twigs, and spurs (pl. 10, A). It differs from other varieties in the Pacific States in that it is more inclined to produce spurs at all nodes on the new wood, including those near the base of large 1-year-old shoots, and to produce twigs by the outgrowth of spurs, and is less inclined to form large shoots at the expense of twigs or to bear fruit on leafless wood.

When the tree is heavily cut back in pruning, vigorous new shoots grow from the point of pruning and from the older branches in any part of the tree, although but few of these shoots make a long heavy growth. The tendency to produce new shoots in all parts of the tree is more pronounced in this than in most other varieties. When slightly headed back but few long shoots develop, although under good growing conditions many short and medium-length ones appear. If not pruned, only occasional, vigorous, new shoots are produced; and these are usually on the older framework branches, although new twigs may appear here and there throughout the tree. Twigs form freely at nodes of 1-year-old shoots and smaller branches. These fruiting twigs make but little growth in length after their first season, but they produce many spurs and are the principal fruit-bearing wood of the variety, remaining productive for many years.

The fruit spurs are large and strong and branch rather freely (pl. 10, C). They form at almost all nodes on 1-year-old wood and are very persistent, remaining thrifty throughout the tree for many years if given sufficient light (pl. 10, B). The branches of spurs are often short lived, owing to their heavy fruit production, but there is a succession of new branches replacing those which die. Spurs which are broken, even along the older branches, are often replaced by new ones if in a part of the tree which is exposed to light. Where the trees are headed back or the branches thinned to induce wood growth, one or more branches of a good number of spurs send out twigs several inches in length. These new twigs often appear along the old as well as on the new wood (pl. 10, D).

When trees are thinned to admit light and only moderately headed back, the twigs which grow from spurs are more numerous but shorter and owing to the short internodes are more heavily leaved (pl. 10, A) than those on the long shoots of trees which have been severely headed back.

The fruit is borne for the most part on leafy spurs which are 2 years old or older, if the trees are making a good growth or have been kept open; although on unirrigated or unthrifty trees many 1-year-old spurs are productive (pl. 10, E). On trees making a rapid new growth many 1-year-old fruiting spurs are leafless and die after the fruit ripens, but on trees growing somewhat more slowly they usually retain their vigor, although bearing fruit. The 1-year-old wood is inclined to fruit sparingly, and the fruit which appears is usually at nodes where spurs are forming, since spurs form at almost all nodes of the new wood. In shaded places, if the crop is excessive, many spurs along both twigs and older branches are leafless and die after the fruit ripens.

As the variety is inclined to produce and retain a thick stand of vigorous spurs and spurlike twigs and these are inclined to be heavily leaved, only light cutting back is necessary to retain the vigor of the wood.

KELSEY

Trees moderately vigorous, upright in growth, and produce both twigs and spurs. The vegetative vigor is confined largely to the newer wood, and most spurs and twigs die out as the wood becomes older. When branches become barren they usually remain so; new spurs or twigs seldom appear on them. If the branches are severely thinned out or cut back or if growing conditions are otherwise made favorable, long new shoots sometimes grow from the older branches.

The new shoots appear mostly on the stubs of headed-back branches, and but few grow on unpruned trees which are in full bearing. They are usually few in number, erect, and stout. The larger ones sometimes send out slender twigs a foot or so in length, and these produce numerous fruit spurs which if not shaded or crowded live for several years.

The spurs are rather slender, brittle, frail, sensitive to shade, and for the most part short lived. If the tree is growing slowly because of drought or is kept open by the thinning of branches the spurs will naturally live much longer than where they are injured by the shade of heavily branched shoots such as grow on trees which have been severely headed back and whose new shoots have not been thinned. In the regions where summers are hot, most spurs of trees which are growing well die after two or three years; but old trees which are growing slowly, especially if they have been lightly pruned, may retain some spurs for many years. To insure a good number of thrifty spurs, a good growth of shoots should be grown each year and these thinned out to admit light for spur development. Twigs often grow from spurs if the tree is kept open and has been encouraged to make wood growth by being headed back or otherwise. These, like twigs in other parts of the tree, develop many spurs and are also slender and make but little terminal growth. They are rather frail and require an abundance of light if they are to remain fruitful.

In the cool coastal region of California, trees of the Kelsey variety which are severely headed back each winter are less vigorous than trees of most other varieties. The new growth is short, the new shoots in the tree tops often being less than a foot in length; and the spurs are short lived, few of them living longer than two years if they bear fruit. In their poor growth in this region these trees compare well with Chalco, Gaviota, Wickson, and Occident.

SANTA ROSA

Tree makes a very vigorous, rapid upright growth and branches freely, producing many spurs and twigs (pl. 11, A).

The new shoots become very long but are comparatively slender. They are numerous on trees which have been heavily headed back and often produce a number of upright branches during their first season's growth. If the new shoots and their branches are numerous, they cause a dense shade and a loss of fruiting wood in the center of the tree. In compact trees which have been headed back most of the large shoots start from the ends of cut-back branches, as the growing vigor of headed-back trees of this variety is very largely centered in the cut-back tops. Trees which have been kept open and headed back only lightly, if at all, produce many shoots along the framework branches. If trees are not pruned or if other conditions prevent a vigorous growth, the new branches are more inclined to spring from the old wood rather than from the new. On vigorous trees which are kept open by pruning, slender twigs and branches ranging from a few inches to 2 feet or more in length grow from the old wood of old as well as new branches and from terminal buds of spurs on both large branches and twigs. Most of these twigs, including the larger ones, grow from the wood of the larger branch itself rather than from the terminals of spurs, thus indicating a lower vegetative vigor of the spurs than of the branch on which they grow.

Spurs form thickly along the 1-year-old wood, leaving but few barren nodes except very near the base of large branches and sometimes along a considerable portion of the most slender ones in shaded interior parts of trees (pl. 11, B). They are slender and branch but little except in well-open trees, live for many years if given light, and remain vigorous and productive (pl. 11, C). When shaded they become frail and soon die, leaving the branch barren. Spurs of the Santa Rosa are probably more quickly injured by shade than those of other commonly grown Japanese varieties and are also less inclined to grow to twigs (pl. 12, A and B). Where the trees are kept open and vigorous, short twigs instead of spurs form on the new branches. These twigs produce several spurs and provide desirable fruiting wood (pl. 12, C).

Fruit is borne on growing spurs throughout the tree and at nodes of 1-year wood where spurs are forming and some at the leafless nodes at the base of 1-year branches and along slender twigs (pl. 11, B). Very little fruit is found on large 1-year-old shoots, but the shorter shoots and larger twigs are very fruitful. Although fruit is produced throughout the tree, the more compact trees bear the greater part of the crop on 1, 2, and 3 year wood, because of better light and therefore more vigorous spurs on this part of the tree.

SATSUMA

Tree upright spreading, vigorous, open; produces numerous spurs and twigs, although but few larger fruiting branches. Strong vegetative vigor is maintained throughout the tree.

Long, vigorous shoots grow from the stubs of cut-back branches and occasionally from the older part of the tree. A smaller number grow as a result of heading back than is usual with most Japanese sorts, and fewer grow from the older part of the tree. They rarely branch their first season but produce numerous spurs and spurlike twigs the second summer. On the more thrifty ones the twigs are numerous. They grow at right angles to the shoot and become several inches in length and produce thrifty spurs. Like other twigs of the Satsuma they are slender but very strong and long lived (pl. 13, A). The spurs are slender but not easily broken, and those on both the twigs and large branches remain productive for many years. Broken spurs and twigs are often replaced by new ones even on the old wood, as are those killed by shade or excessive crops when there is a change in condition which favors their growth. Owing to the persistence of spurs and twigs and this continuous replacement, this variety is one of the best in respect to production and maintenance of fruiting wood (pl. 13, B and C).

The fruit is borne mostly on leafy spurs and at nodes of the 1-year twigs where spurs are forming. In decidedly shaded portions of the tree, particularly those which have been regularly and severely headed back, leafless spurs bear and die after the fruit ripens.

WICKSON

Tree thrifty, upright, forms many fruiting branches, and is among the varieties most inclined to produce spurs (pl. 14, A).

Following heading back, new shoots spring from near the points of pruning and along the main branches if the tree is open, and then mostly near points where branches have at some time been removed. New twigs appear as an outgrowth of spurs or from a terminal bud of a twig but uncommonly from lateral buds on 1-year-old wood. The new shoots are not so long as those of most other varieties, but they are stout and, because of their short internodes, are heavily leaved. Although the new shoots are somewhat shorter on trees of the Wickson than on those of other Japanese varieties, the spurs on the 1-year-old shoots are usually more vigorous.

Spurs form at almost all nodes of 1-year-old wood on large shoots as well as on small twigs, although short twigs instead of spurs are occasionally produced at the nodes of both large and small shoots. The twigs are usually slender but produce many spurs and are very prolific (pl. 14, B). The spurs live for many years if the tree is growing well and has been kept open, but if the top is compact those in the interior of the tree are soon eliminated by shade. Where the trees are not vigorous, annual wood growth is short, necessitating severe cutting back to induce the growth of twigs. The new twigs grow from the terminals of young spurs or from the nodes of the short section of the 1-year-old wood which remain after pruning. This leaves but few spurs of wood more than a few years old. The twigs and spurs on such twigs are slender and brittle and easily broken during the fruit harvest. Many of them must be removed to permit the fruit on the remaining ones to grow to good size. Such trees produce their fruit on wood of but a few years of age, as the remainder of the branches are barren (pl. 14, C).

Where little or no pruning is done, spurs form at terminals of twigs and larger branches, and these as well as lateral spurs remain for many years. On such trees there is but little growth of twigs or new shoots (pl. 15, A).

In the cool coastal regions the spurs on trees which have been annually headed back and which are growing in deep, irrigated soil have remained well down in the center of the tree, but the growth of shoots is much shorter than on trees in the warmer sections. Tops that have been headed back appear to have gradually lost their vigor, and new shoots which appear are often produced along the old framework branches.

Fruit of this variety is borne on spurs, on 1-year-old twigs, and to some extent on the shorter 1-year shoots growing on branches which have been headed back. On trees which are making a poor growth the crop is heaviest on 1-year-old twigs and on spurs 1 to 3 years old. Most fruit is found on spurs with leaves or at nodes of 1-year-old twigs where spurs are forming, although toward the base of the slender twigs most fruits are at leafless nodes. The leafless section at the base of larger shoots is shorter with this variety than with most others.

Cutting back to induce a moderate growth of strong branches while the tree is young, thinning to admit light, and later shortening twigs and branches sufficiently to maintain vigorous spurs and considerable twig growth from spurs would appear to be the most desirable method of pruning for this variety (pl. 15, B).

VARIETIES OF THE PRUNUS DOMESTICA GROUP

AGEN (FRENCH PRUNE OR PETITE PRUNE)

Tree round topped, spreading, vigorous, branches freely, makes numerous fruiting branches and twigs throughout the tree, and is inclined to continue terminal growth of all branches, twigs, and spurs (pl. 16, A). The small branches and twigs often remain slender, and if shaded or crowded they become drooping. The twigs and spurs are persistent. When well established, they remain thrifty for many years and by branching and increasing in length gradually form a compact tree.

Though inclined to form twigs rather than spurs, when bearing excessive crops or under cultural conditions unfavorable to wood growth, spurs form on terminals of branches and twigs and in place of twigs along branches. In this case the internodes of branches and twigs are short, and concentrated

loads of fruit cause the branch to bend with its load and often to become sunburned. Small fruit only may be expected where twigs cease to grow and spurs only are formed. Thinning out of branches or the improvement of growing conditions will be needed to cause an increase in wood growth (pl. 16, B).

Although wood growth is gradually checked by unfavorable conditions, the effect on trees of this variety is less prompt and less marked than with most varieties, and branches and twigs continue to lengthen under adverse conditions longer than with most other sorts.

Most of the fruits are borne along the basal portion of 1-year-old twigs and on spurs. Fruit is also occasionally found near the base of rather large 1-year-old shoots. When on 1-year-old wood it is usually found at leafless nodes of slender twigs, although sometimes at nodes of vigorous 1-year-old branches where spurs are forming.

Plantings of this variety are confined almost entirely to the deep, fertile, valley soils, and the annual heading back practiced with most varieties is rarely given the Agen. The customary pruning of the bearing trees consists in an occasional light thinning out of branches. No pruning at all is done for long periods in a large number of orchards.

Where the new growth is severely headed back each year numerous thrifty shoots and twigs are produced, and the trees are vigorous and productive. The favorable response to severe heading back of the 1-year-old wood in the few examples which have been observed indicates the benefit, in larger sizes of fruit, to be derived by pruning trees that are making a poor growth (pl. 16, C and D).

Thinning sufficiently to admit light and to insure a thrifty growth of twigs should result in a good crop of large-sized fruit, but the compact growth of stunted branches will result in small fruit.

CALIFORNIA BLUE

Tree moderately vigorous, with broad, rounded, spreading, open top; produces many spurs and maintains them well down along the old branches. It is inclined to send out but few secondary or fruiting branches, unless encouraged to do so by being headed back, and produces new shoots from the terminal buds of shoots of the previous season (pl. 1, B, and pl. 17, A).

When branches are cut back, vigorous shoots spring from immediately below the point of pruning, but these are usually few in number. They rarely spring from framework branches except under conditions very favorable to wood growth, and then usually at a point where a branch was removed, but almost never on unpruned or lightly pruned trees. On both severely and lightly pruned trees much of the growth of new shoots, aside from that which occurs immediately below the point of pruning, is from the terminal of the larger, unpruned branches rather than on spurs or twigs. On such trees many short branches and twigs grow from terminals of spurs and in all parts of the tree (pl. 17, B). In unpruned or lightly pruned trees few twigs grow from spurs, and these are shorter than on trees of most other commonly grown varieties of the domestica group. Unlike many varieties, the California Blue continues terminal growth of the larger branches for a number of years after pruning has been discontinued, if conditions are otherwise favorable to wood production (pl. 17, A).

When the framework branches are numerous and have but few lateral branches they remain slender, but become longer by the continued terminal growth if not headed back and often bend badly with a load of fruit. Care should be taken to select strong, well-spaced framework branches and to prune so as to induce the desirable branching and to prevent too long a growth of the branches.

If not irrigated, trees of fruiting age soon cease to make terminal growth except to form spurs, and the heading back of branches is necessary to maintain sufficient vigor in the trees to produce profitable crops (pl. 1, B).

The spurs are of the single-leader type, increasing their length from year to year. Some spurs finally reach several inches in length. When the spurs are young they branch but little, although branches may grow from any part of them; and both the spur leader and its branches continue terminal growth if the tree is open and good growing conditions prevail. On trees which have been headed back in pruning, numerous spurs send out twigs or good-sized

shoots. Also, an occasional twig appears on vigorous, unpruned trees in irrigated orchards. The older part of the spur becomes stout and strong and is not easily broken from the trees, but the branches of the spur and its new terminal growth are readily broken. Many of the spurs which are broken off are replaced by new ones, more quickly than with almost any other variety. This indicates a strong vegetative vigor in the older wood (pl. 17, C).

Leaves of this variety are of medium size, have short petioles, and often tend to curl. These qualities aid in keeping the tree open and in admitting light.

Fruit is borne on spurs in all parts of the tree and also on nodes on 1-year-old wood (pl. 17, D and E). Fruits are seldom found on leafless spurs or at nodes of 1-year wood where spurs are not forming, except for a short section at the base of the 1-year-old wood. The vigor of spurs and twigs and the tendency to produce leaves and form spurs at barren nodes on 1-year-old wood are more pronounced than in almost any other variety. This variety is inclined to produce heavy crops, but only in alternate years.

CLYMAN

Tree vigorous, upright, open, and branches sparingly, except for spurs and twigs which appear along the entire length of the branch (pl. 18, A). With the little branching that occurs, an abundance of light is admitted to all parts of the tree.

New shoots spring from near the point where branches are headed back or removed and from the terminals of shoots of the previous year and occasionally from spurs. They make a stout, erect growth, but are not numerous, and make a vigorous growth if the tree is growing in irrigated soil and the new wood is headed back each year. Under these conditions of growth new shoots grow almost entirely from the 1-year-old shoots which were headed back. This causes shade below and the loss of most spurs and twigs. On such trees there is a heavy set of spurs on the newer wood, and heavy crops are produced in the newer part of the tree (pl. 18, B).

Spurs are retained for many years if the tree is kept open, and they continue to be productive. They are of greater diameter than spurs of most varieties, but remain short, except that under good growing conditions an occasional one grows to a twig of several inches in length. The fruiting branches retain their vigor well, and a spur which has been broken off is often replaced by a new one, thereby maintaining a supply of fruiting wood.

Fruit is borne on 1-year-old twigs and on spurs of all ages throughout the tree. On the 1-year twig the fruit is usually found at nodes where spurs are forming and uncommonly at leafless nodes. The inclination to form spurs along the more slender 1-year twigs and branches is more pronounced than with most varieties, and only a short section of the base of the branches is without spurs. Only a few fruits appear on the large 1-year-old branches, although numerous spurs which are retained for a long period form along them (pl. 18, C).

DIAMOND

Tree vigorous and upright spreading, producing many large branches which divide freely into fruiting branches and twigs (pl. 19. A). New growth starts from almost all nodes of 1-year wood, both on small twigs and on large branches and even at nodes of slender 1-year-old twigs which are producing fruit, a characteristic more pronounced with this variety than with any other herein listed (pl. 19, B). On the short slender twigs this new growth consists largely in the development of fruit spurs, and along the larger 1-year-old branches it is of twigs or fruiting branches. All terminal buds, both of spurs and larger branches, are inclined to continue length growth instead of remaining as short spurs or twigs; and where conditions are favorable for wood growth the trees soon become compact if not kept open by pruning. Trees not irrigated or those pruned lightly, if at all, produce relatively more fruit spurs, the slender twigs throughout the tree being well set with them. Fruits on such trees are small if crops are regular; therefore thorough thinning out of branches, accompanied in dry places by heading back, is needed to insure the growth of large-sized fruit (pl. 19, C).

The fruit spurs which do not grow to twigs remain slender, seldom branching, and are inclined to be short lived. Few of those which do not grow to twigs

remain more than three or four years. Those which are not sufficiently vigorous to make some twig growth during the summer and do not bear fruit are easily killed by shade. Also, much of the vigor of the fruiting spurs is lost by the production of heavy crops, and many fruiting spurs die after the fruit ripens. The spurs which die or those broken off are seldom replaced by new ones, as the tendency to make new wood is centered very largely in the terminal buds of twigs and spurs rather than along the branches on which they grow. By cutting back the branches and opening the tree to admit light, a vigorous growth of twigs is obtained; and the supply of prolific fruiting wood is easily maintained. If trees are making only a fair wood growth and the new wood is moderately cut back in winter and the trees are kept open, when bearing fruit regularly, they retain spurs and twigs longer than heavily pruned trees which make a strong yearly growth.

On trees which are heavily headed back in pruning, long, new shoots grow from near the point of pruning, whereas the new growth in the older parts of the trees is usually short and slender. The large shoots send out numerous branches and twigs their second season, but few if any spurs such as are produced all along the slender twigs grow on them.

If summer temperatures are low, as in the cooler coastal region of California, and the 1-year-old wood has been headed back each winter, the new shoots near the ends of the cut-back branches are very vigorous and reach several feet in length, whereas the new growth in other parts of the tree is proportionately shorter and more slender than in the case of most varieties (pl. 20, A and B). In the tendency for the vegetative vigor to be proportionately much stronger in the headed-back tops than in the remainder of the tree, where growing in the cooler region, this variety is similar to the Grand Duke and Peach.

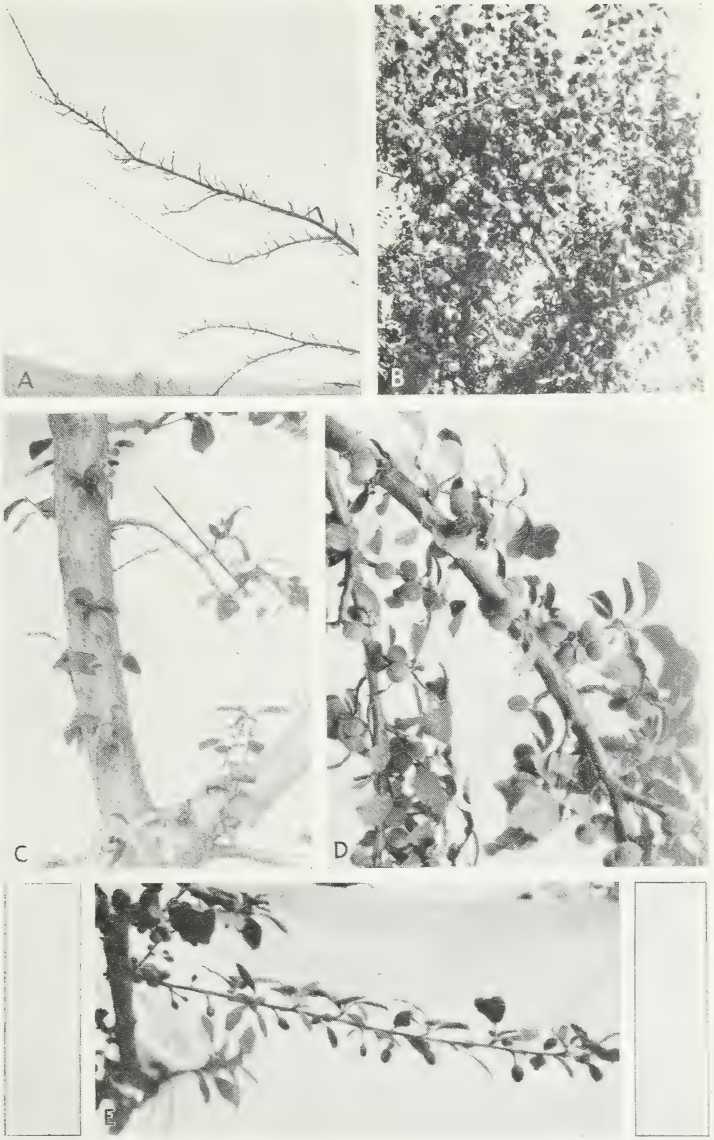
Fruit is produced, for the most part, at nodes of 1-year-old twigs and smaller branches where spurs are forming and on 1-year spurs. Spurs which have borne only a light crop or none at all when 1 year old bear well when 2 or 3 years old, and if the tree is making a moderate wood growth and has been kept open they may bear for a few successive seasons. Little, if any, fruit is produced on 1-year-old twigs or shoots. The internodes of twigs and smaller branches are short, resulting in a rather compact cluster of fruit if the spurs have been kept vigorous by open pruning and if the twigs are short because of lack of soil moisture.

GIANT

Tree very vigorous, upright spreading, moderately open, and branches freely. The vigorous shoots which grow as a result of heading back the top make a heavy, erect growth, but the twigs and branches in other parts of the trees are slender and inclined to bend or droop (pl. 21, A). Its tendency is to produce twigs rather than spurs (pl. 21, B).

The twiglike spurs which form on 1-year-old wood are short and unbranched, and almost all die at the end of the first season if they bear fruit. Spurs which are sufficiently vigorous to produce both fruit and leaves seldom remain as spurs but grow to twigs and branches, leaving no spurs on the older wood (pl. 21, C). The twigs and fruiting branches increase in diameter but little. After a few years they become long, slender, drooping branches by annual lengthening from the terminal bud. When growing conditions are unfavorable the yearly growth is very short, and a spurlike rather than twiglike growth takes place at the end of twigs and branches. New twigs appear from these spurlike twigs when conditions for wood growth improve. Where the crop on unpruned trees is heavy much fewer lateral twigs and spurs are produced on the 1-year-old wood than on trees which were headed back or where the crop was light. The tendency to produce terminal growth from all twigs and branches is, however, so strong with this variety that under moderately favorable growing conditions plenty of new growth is produced, even on unpruned trees, to provide for regular cropping. In densely shaded portions of the tree the lateral twigs are often short and slender and many die after fruiting. This and the barren nodes at which fruit is borne on the 1-year-old wood result in long barren sections of the branch, as new twigs seldom spring from the old wood.

The fruit is borne on leafless nodes along the basal section of the 1-year-old twigs and smaller branches, occasionally at nodes of 1-year-old wood where twigs are growing, and on 1-year-old leafless spurs, or spurs which have only



GROWTH, FRUIT SPURS, AND FRUITING HABITS OF THE CALIFORNIA BLUE PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Branch of a tree which has not been pruned for several years. Note that much of the new growth is from the tips of branches and that spurs are retained along older wood. The tree is growing in fertile irrigated soil. (Newcastle, Calif.)

B.—Branch of a tree which has been severely headed back each year and is growing in fertile irrigated soil. Note the vigorous growth of shoots and twigs in all parts of the tree. (Compare with A. Newcastle, Calif., May 26, 1923)

C.—An 8-year-old branch of a vigorous tree. Note the new spurs (near pencil) which are growing at points where old spurs were broken off last year

D.—A 7-year-old-branch of a tree which has been very lightly pruned. Note the persistent and fruitful spurs, instead of twigs and shoots such as appear on severely pruned trees. (Compare with B. Newcastle, Calif.)

E.—A 1-year-old fruiting twig of a thrifty tree. Note the production of fruit at numerous nodes where spurs are forming on this 1-year-old branch. A strong varietal tendency to produce spurs is indicated. (Newcastle, Calif., April 11, 1923)

SPUR GROWTH AND FRUITING HABITS OF THE CLYMAN PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Shoots of An 8-year-old branch of a tree which has not been pruned for several years

B.—Fruiting branch of a tree which has been severely headed back each year, with a heavy crop of fruit on the young spurs. Most spurs along the older portion of the branches have been lost, as most of the vigor is in the ends of cut-back branches. The tree is growing in fertile irrigated soil. (Compare with C. Niles, Calif.)

C.—A 9-year-old fruiting branch of a tree which has been only lightly cut back and thinned out and is growing in fertile well-irrigated soil. Note the persistent and prolific spurs. (Compare with B. Courtland, Calif.)

GROWTH AND FRUITING HABITS OF THE DIAMOND PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—I

A.—A 15-year-old tree before pruning, growing in fertile irrigated soil. Many new shoots are headed back in winter and some branches removed to admit light. Note the numerous fruiting branches and twigs

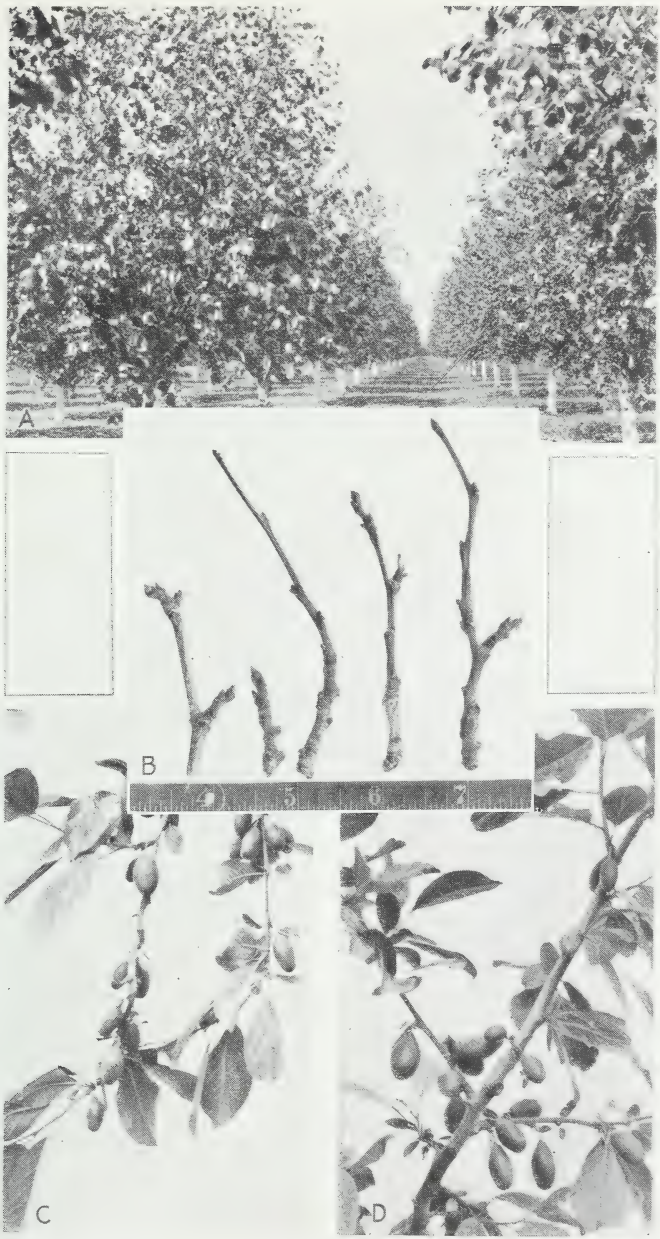
B.—A slender fruiting branch showing growth of both fruit and spurs or twigs at nodes of 1-year-old wood

C.—Several 16-year-old Diamond plum grafts top-worked on apricot, after pruning. The soil is deep and fertile but not irrigated. Severe heading back of the new wood and thinning out of branches has been necessary to insure regular production and large fruit. (Vacaville, Calif.)

GROWTH AND FRUITING HABITS OF THE DIAMOND PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS.—II

A.—Fruiting twigs along framework branches of the tree shown in Plate 20, B. The twig with dead spurs is 5 years old. The other one is 3 years old

B.—A tree growing in the cool coastal region of California. The new growth has been heavily headed back each winter. Note the vigorous growth of shoots in the top of the tree and only short growth elsewhere



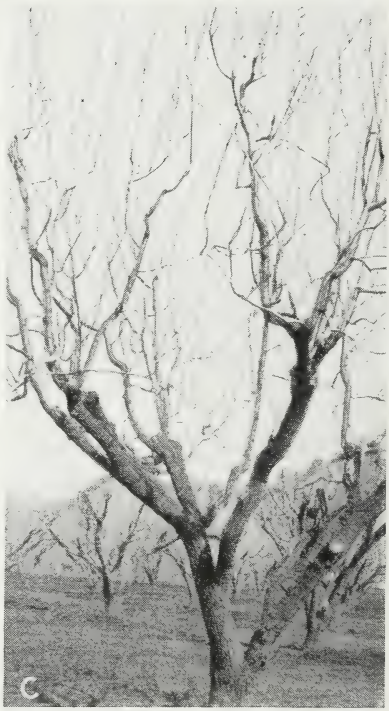
GROWTH, FRUIT SPURS, AND BEARING HABITS OF THE GIANT PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Trees which have been moderately cut back and the branches thinned lightly each year. (Santa Clara, Calif., October 7, 1924)

B.—Twigs and spurs from a thrifty tree

C.—Fruiting branch showing fruit on leafless 1-year spurs or those which have only small leaflets and on short spurs which are growing on twigs. The tendency of this variety is to produce twigs and not to retain spurs

D.—Fruiting branch on a tree which has been severely headed back and thinned out each winter and is growing in fertile irrigated soil. Note that most fruits are at leafless nodes and leafless 1-year-old spurs, even on the vigorously growing branches



GROWTH RESPONSE OF GIANT PLUM TREES TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Trees 13 years old which have not been pruned for 10 years except for the removal of an occasional branch. They produce good and regular crops of moderate-sized fruit. The soil is fertile and the orchard under irrigation. (Newcastle, Calif.)

B.—A thrifty irrigated tree on which the 1-year-old shoots have been headed back each winter to insure large fruit. Note the heavy growth of new shoots and also fruiting branches and twigs throughout the tree. (Newcastle, Calif.)

C.—Giant plum grafts top-worked on apricot. The orchard is not irrigated, but the soil is deep and fertile. Annual heading back was practiced until one year ago, when little or no pruning was done. Note the short wood growth which was made last year; also lack of fruiting wood in the older part of the tree. (Vacaville, Calif.)

FRUIT-SPUR DEVELOPMENT AND BEARING HABITS OF THE GOLDEN DROP PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Outside branches of a tree which has been headed back each year. The tree is in fertile soil and has been well irrigated. (Photographed after the annual pruning. Niles, Calif.)

B.—Vigorous spurs from a tree which has been annually headed back and is growing in fertile irrigated soil

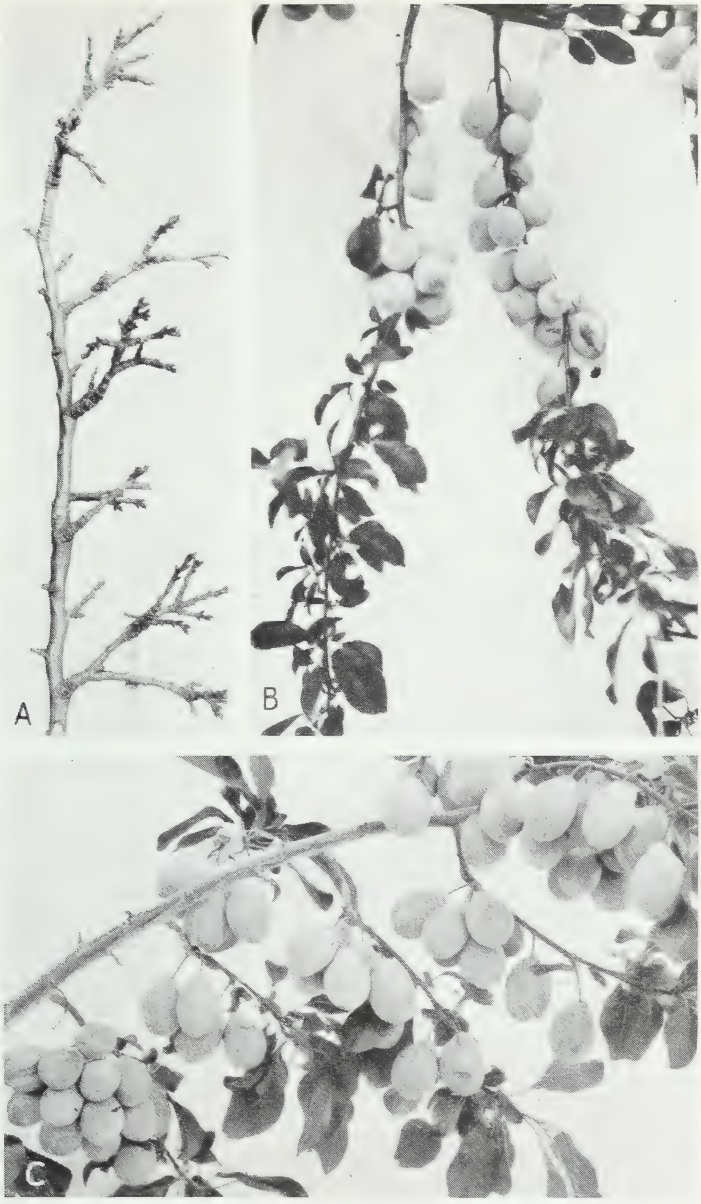
C.—Branches of a tree which has been headed back each year and is growing in fertile irrigated soil. The branch at the left is at the outside of the tree, and the one at the right, which made a little less vigorous growth, is in a more shaded portion. Note the production of fruit at leafless nodes on 1-year-old twigs on the branch at the left and on leafless spurs on the one at the right

D.—Secondary branch of an 18-year-old tree which has been headed back each year and is growing in fertile irrigated soil. Note the barren section where spurs have died after fruiting and the leafless barren spurs which will die after the fruit ripens

GROWTH AND BEARING HABITS OF THE GRAND DUKE PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Fruiting branch of a tree which has been cut back each year. Note that only larger twigs have been retained, that fruit is borne mostly at leafless nodes and on leafless spurs on twigs, and that no fruit set on the 1-year old shoots. Tree growing in fertile unirrigated soil. (Vacaville, Calif., July, 1923)

B.—A 10-year-old framework branch of a tree which is growing in deep, fertile, but unirrigated soil. The annual cutting back of twigs and larger branches has maintained vigor and insured production of large fruit



FRUIT-SPUR DEVELOPMENT AND BEARING HABITS OF THE GRAND DUKE PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Old fruiting branches on a tree which has not been pruned for many years, growing in fertile irrigated soil. (Note contrast with branches in pl. 24, B)

B.—Fruiting branches of a tree which is growing in fertile irrigated soil and has been headed back each year. Most fruit is found at leafless nodes near the base of 1-year-old wood and on short leafless 1-year-old spurs on 2-year wood. The leafless 2-year-old wood will be barren next year. (Newcastle, Calif., July, 1922)

C.—A 3-year-old fruiting branch of a tree which is growing in fertile irrigated soil. Note fruit at leafless nodes of 1-year-old wood. These twigs grew from terminals of 1-year-old twigs and spurs which did not fruit last year. Short spurs which fruited last year and died after the fruit harvest are seen along the main branch. (Yakima, Wash.)

GROWTH, FRUIT SPURS, AND BEARING HABITS OF THE IMPERIAL EPINEUSE PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Fruiting branches of a tree growing in an unirrigated orchard in a region where summer temperatures are high. These branches were headed back each year until recently. Note the numerous thrifty spurs but lack of shoots and twigs. (Vacaville, Calif.)

B.—Some 10-year-old branches which have borne light crops and have been but lightly pruned. The tree is growing in a region where summer temperatures are moderate and in soil not irrigated. Note the numerous spurs, twigs, and fruiting branches. Fewer twigs are found on lightly pruned trees which have borne well. (Healdsburg, Calif.)

C.—An 8-year-old fruiting branch which has been headed back and thinned out each winter, only one shoot being allowed to remain. The soil is not irrigated and is in an interior valley of California where summer temperatures are high. Note the new shoots on the newer wood and the fruiting twigs which are the outgrowth of spurs. (Vacaville, Calif.)

D.—A 16-year-old tree growing in deep irrigated soil in the cool coastal region of California. The new shoots have been severely headed back each winter. Note vigorous wood growth. There has been a thrifty development of twigs and spurs throughout the tree, and the crops have been heavy. (Niles, Calif., June 30, 1923)

E.—Framework branch of a 16-year-old tree. The 1-year-old shoots have been severely headed back each winter. The tree was grown in the cool coastal region of California. Note growth and production of twigs and spurs. (Niles, Calif., June 30, 1923)

GROWTH AND FRUITING HABITS OF THE ITALIAN PRUNE

A.—A vigorous 3-year-old branch. Note numerous fruiting twigs instead of spurs, and fruit at leafless nodes. (Salem, Oreg., July 26, 1923)

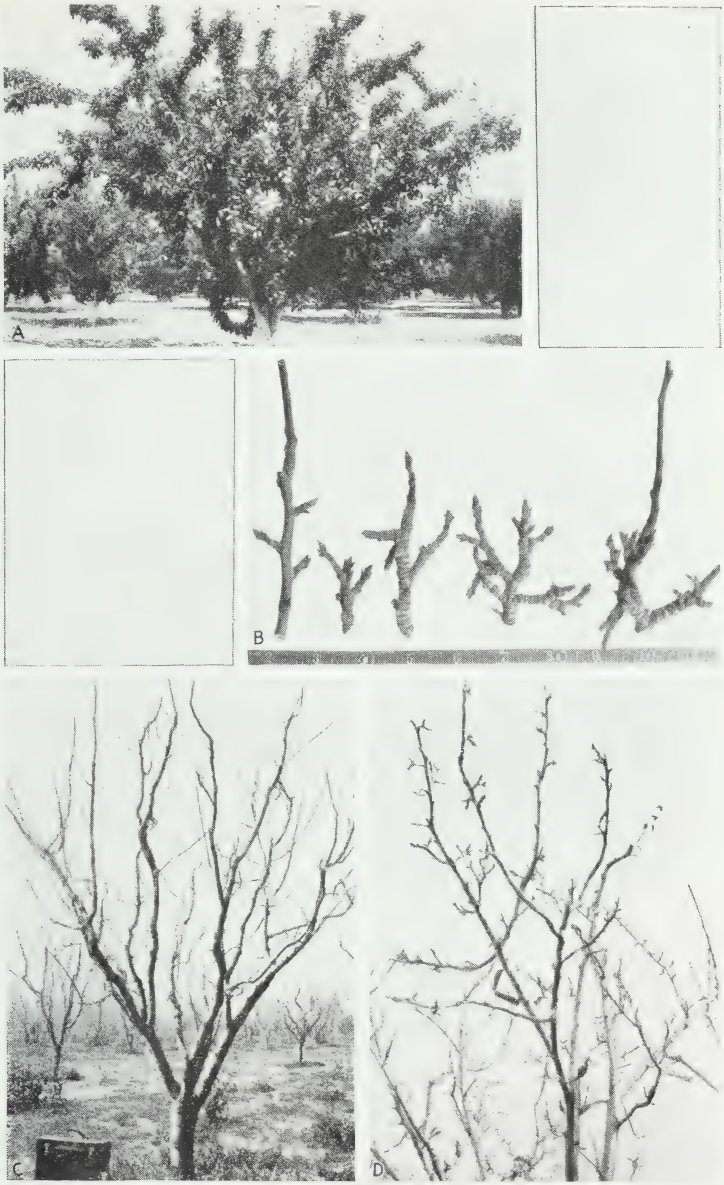
B.—An 11-year-old fruiting branch which has not been pruned. The tree has made a slow growth. The main branch has grown but little, while the lateral twigs have lengthened and branched from year to year. (Salem, Oreg.)

C.—Slender fruiting branch bent by load of fruit. Sunburning is often severe on such branches

GROWTH AND DEVELOPMENT OF THE ITALIAN PRUNE IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Three 18-year-old fruiting branches in the interior of an old tree. The twigs along the older wood have lost their vigor and have died or been pruned out. These fruiting branches have grown from lateral twigs by yearly branching of the most vigorous new shoots, but without a definite leader

B.—A tree on which the annual pruning practiced has been thinning out and cutting back branches. The tree is unirrigated, but a soil mulch has been maintained by frequent tillage. The desired supply of vigorous fruiting wood has been maintained. (The Dalles, Oreg., August, 1921)



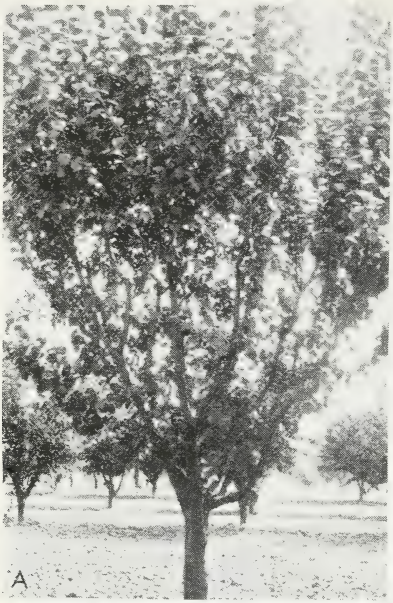
GROWTH AND FRUIT-SPUR DEVELOPMENT OF THE JEFFERSON PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A 15-year-old tree growing in fertile irrigated soil. The top has been kept open by regular thinning out and light heading back. A thrifty growth of spurs has been maintained throughout. The new shoots are not numerous. (Linden, Calif., July 12, 1924)

B.—Spurs from a thrifty and prolific tree which has been moderately cut back and thinned out each year. The tree grew in deep irrigated soil

C.—A 16-year-old tree growing in fertile irrigated soil. The new growth has been severely headed back and thinned out each winter, but scattered fruit spurs remain. (Compare with D. Niles, Calif.)

D.—Fruiting branches of an old tree which has been thinned out but only lightly headed back in winter. (Compare with C. Courtland, Calif.)



GROWTH, FRUIT SPURS, AND BEARING HABITS OF PEACH AND POND PLUM TREES IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A 16-year-old Peach plum tree on which the 1-year-old shoots have been severely headed back each year. Note the vigorous wood growth near the points of pruning and the light growth elsewhere

B.—Old Pond plum grafts top-worked on apricot. This tree is growing in fertile unirrigated soil, and severe heading back and thinning out each year are required to maintain the vigor necessary for the production of large fruit. Note that little fruiting wood remains along the older portion of the branches

C.—Slender interior fruiting wood of a Pond plum tree which has been severely headed back. Note the short wood growth and the fruit on 1-year-old spurs which are leafless or have only small leaflets. These spurs will die after the fruit ripens

D.—Vigorous fruiting branch on the outside of a vigorous Pond plum tree grown under irrigation. (Note growth of twigs and contrast with C)

GROWTH AND FRUIT-SPUR DEVELOPMENT OF THE PRESIDENT PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Several 7-year-old President plum grafts top-worked on peach and growing in fertile irrigated hillside land. The annual pruning practice is indicated by the branching. Note the fruit spurs throughout the tree. (Compare with C)

B.—Branches on a tree which has been kept well open and moderately headed back each winter. The soil has been irrigated and is moderately fertile. (Compare with D)

C.—A number of 15-year-old President plum grafts top-worked on apricot. The soil is deep and fertile but not irrigated. It has been necessary to head back the new shoots severely each winter to induce a vigorous wood growth. The twigs are slender and produce fruit instead of spurs, or, if spurs develop, they fail to produce leaves when 1 year old and die after fruiting. (Compare with A and pl. 32, A. Vacaville, Calif.)

D.—An 8-year-old fruiting branch of a tree which grew in an unirrigated section where the annual wood growth is short and fruit is borne on 1-year-old branches instead of spurs. Each year the new shoots were headed back to below the point to which spurs were produced to maintain the vigor necessary for the production of large fruit. (Compare with B)

GROWTH, SPUR DEVELOPMENT, AND BEARING HABITS OF THE PRESIDENT PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Slender 1-year-old twigs, showing fruiting tendency. If the leaf-bearing portion of the twig is removed the entire twig will die after the fruit ripens. A vigorous growth is needed by trees of this variety, as few spurs form on slender branches

B.—Several 9-year-old President plum grafts top-worked on peach and growing in fertile irrigated land. The new shoots have been heavily headed back each winter. Note the spurlike twigs which grow at right angles to the large shoots during their first season. (Compare with C)

C.—A 9-year-old tree which has been headed back in pruning and is growing in fertile irrigated soil. Note the spurlike twigs which were produced by this branch during its first season's growth. (Compare with B and pl. 31, C)

small leaflets and which die after fruiting, the same as do leafless spurs (pl. 21, D). It is rarely produced on the long new shoots which grow after the tree has been heavily headed back, although when this wood is 2 years old it bears heavily on the twigs and spurlike growth produced the previous year.

If little or no pruning is practiced, the new growth is slender and of only moderate length, and the tree soon becomes spreading or drooping from carrying loads of fruit. On account of their strong vegetative vigor, however, trees of this variety which are irrigated and growing in fertile soil remain thrifty and produce regular crops of good-sized fruit where but lightly pruned (pl. 22, A). If heavily cut back, very rampant shoots spring from near the point of pruning (pl. 22, B). These new shoots have large, heavy leaves and cause a dense shade in the center of the tree. Where water for irrigation is lacking, especially on soils low in fertility, the growth following pruning is only moderate, and considerable cutting back is necessary to insure the needed new growth. Under the latter conditions, little or no pruning results in short wood growth and therefore restricted bearing surface and often in small fruit (pl. 22, C).

Under conditions favoring a moderate wood growth, this variety is more inclined to produce twigs from the terminal buds of its twigs and branches and less inclined to retain lateral fruiting spurs than almost any other of those commonly grown in the Pacific States. The Italian Prune is among the possible exceptions. The Agen (*French prune*), which is thought to be one of the parents of the Giant, resembles it closely in that the new growth develops from the terminal buds; and the variety thought to be the other parent, the Pond, resembles it closely in its tendency to retain no fruit spurs.

For a pruning method, light thinning of interfering branches, the cutting back of some of the long bending branches which require props when fruiting, and the removal of branches to admit sufficient light appear to bring satisfactory results where orchards are irrigated and the soil is at least moderately fertile. The cutting back of long drooping branches and training to develop strong upright leaders is particularly desirable on the fertile, deep, irrigated soils where there is a strong wood growth. On unirrigated soils considerable cutting back of both new shoots and fruiting twigs is required to maintain the thrifty wood growth needed for the development of large fruit.

GOLDEN DROP (SILVER PRUNE)

Tree upright spreading, open, only moderately vigorous, very sensitive to shallow soil and drought, and branches but little except for the growth of fruiting twigs and spurs. It is probably less inclined to send out new shoots from the terminals of the previous year's shoots than any other variety studied. Of the more distinctly spur-producing varieties, it is less inclined to retain spurs or to replace those which die or are broken off.

The new shoots spring from near the point of cutting back of the branches, but they seldom grow from the old wood unless induced to do so by pruning. When old branches are shortened the new shoots, which are usually short, grow from terminals of vigorous spurs just below the point of pruning. Cutting back new shoots causes an occasional spur to produce a twig or short shoot, but aside from this the spurs make only a short annual growth (pl. 23, A).

Thrifty spurs grow to considerable length the first summer, and if the tree is growing well they increase in length each year (pl. 23, B). They often produce several branches, and under good growing conditions one of the branches may grow to a twig or longer shoot. In this case the other spur branches perform as normal spurs. The spurs are very sensitive to shade. They form in good number along the 1-year-old wood, or if this wood is above the normal in vigor fruiting twigs develop instead of the short spurs found on less vigorous shoots. These twigs produce both terminal and lateral spurs in their second year. Although the spurlike twigs remain vigorous and prolific for several years, the short spurs usually disappear within a few years (pl. 23, C). On large vigorous branches spurs have been found on 15-year-old wood; but on the more slender branches, where they are usually short and slender, they often disappear after their first crop of fruit has ripened. This early dying out of spurs leaves the many barren branches found so commonly in the Golden Drop (pl. 23, D).

The Golden Drop is inclined to bear fruit on alternate years. The slow wood growth made during years of heavy crops is inclined to be unfruitful the following year, and the vigorous wood growth made during seasons when the

crop is light often results in the basal section of the branch being barren the following year, although the remainder of it is supplied with spurlike twigs which bear heavily when 1 year old. If the tree is bearing a heavy crop many spurlike twigs as well as spurs die after the fruit harvest, and if the tree's vigor has in some way been reduced more spurs will be lost than otherwise. New spurs do not appear along the older branches but only on the new wood, and new twigs seldom grow from older branches except as a result of pruning.

Fruit is borne usually on leafless spurs, although the longer and more vigorous spurs or spurlike twigs which are making terminal growth produce good crops at leafless nodes near the base, as do some of the shorter 1-year-old shoots which occasionally appear along the body branches of trees which have been headed back. The tendency of the variety is to bear fruit on spurs of all ages and at leafless nodes of the short twigs which grow in place of spurs on large 1-year-old shoots, but seldom at nodes of long slender twigs or on large 1-year shoots.

Trees lightly pruned or not pruned at all produce spurs along all terminal branches, but cease twig growth almost entirely. After a few years the spurs and twigs gradually die out, leaving the tree very barren and unproductive. Where regularly and heavily headed back, the new growth is often slender and most of it confined to points near where branches were removed in pruning. Many spurs on 2 and 3 year wood of such trees soon die out, like the older spurs and twigs of unpruned trees, if the part of the tree on which they grew is not above normal in vigor. Therefore, regular and heavy cutting back as well as too little pruning often results in reducing the fruit-bearing wood.

Pruning to develop a good number of branches, removing the more slender ones which are barren of spurs, and moderately cutting back new branches to promote the development and maintenance of thrifty spurs and twigs should give the best returns in fruit. Care must be taken to prevent breaking spurs when harvesting the fruit and in pruning, as new spurs seldom replace those which have been removed.

GRAND DUKE

Tree upright spreading, vigorous, open; branches freely, making but few large branches. It is inclined to produce many small fruiting branches and twigs. Although many of these remain very short, often only spurs if the trees are not pruned, they quickly grow to twigs on cut-back branches which are given light. The fruiting section of the twigs is inclined to be barren after the fruit harvest, because of the strong tendency to bear fruit at leafless nodes.

After the 1-year-old wood is cut back many twigs are produced along the portion remaining, and under favorable conditions some grow from spurs of wood a year or two older. New growth of twigs usually takes place at the terminal bud if the twig or branch is not cut back. As the fruiting nodes of the twig remain barren after the fruit ripens, the twig lengthens but remains slender and is often barren except for the 1-year-old portion. Short lateral twigs appear at some nodes of 1-year-old wood which are not bearing fruit; and although many of these die during their second or third summer, if they bear fruit, a few of the larger ones increase in length and remain typical twigs. These are always well out on twigs that are not cut back or near the stub of a cut-back twig. Well down on the 1-year-old shoots any twigs which appear are short and many die after fruiting, as short twigs often bear heavily and practically all fruiting nodes of 1-year-old wood are leafless and barren after fruiting. This often leaves a large part of the branch barren after the fruit harvest (pl. 24, A).

In the cooler coastal region, trees which have not been headed back each winter do not make a thrifty wood growth. All but a short terminal section of the twig is barren, and many entire twigs are lost after a heavy crop of fruit is borne.

In regions where the summer temperatures are high, twigs live for many years; but if the trees are not irrigated the cutting back of much of the 1-year-old wood throughout the tree is necessary to produce the desired twig growth (pl. 24, B). Very few twigs, but spurs instead, are produced after a year or two if the trees are pruned very lightly or not at all, and the terminal growth of even the larger branches is short. If pruning to induce wood growth is not resumed, spurs only will be found even at most terminals (pl. 25, A).

The spurs branch and remain thrifty for many years but increase very little in length and produce small or irregular crops. Old spurs are rarely found on trees which have been regularly pruned to induce numerous fruiting twigs and are growing well. Much of the new growth at nodes of 1-year-old wood on trees of fruiting age is very short and may be classed as spurs. The number of these which grow to longer twigs is comparatively greater when the growth of the previous year is cut back. The section of the branch producing short lateral spurs is very prolific while the spurs are young. Many of these spurs are leafless and die after their fruit ripens. Those among these lateral spurs which bear fruit and live rarely fruit the following season; but many of them grow to twigs. On the larger, more thrifty twigs much of the crop is borne on 1-year leafless spurs, but with the shorter, more slender twigs much of the 1-year-old wood bears fruit, and all but a small percentage of it is at leafless nodes (pl. 25, B). On the large, thrifty, cut-back branches which are given abundant light, new spurs sometimes grow to twigs while bearing fruit. It is on 1-year twigs and 1-year spurs that much of the crop is produced, as but few spurs live after fruiting; or, if not fruiting, grow to twigs. The need for cutting back twigs or branches in pruning and providing conditions favorable for a thrifty twig growth is therefore apparent (pl. 25, C).

Where twigs or spurs die or are broken off, new ones are seldom produced in their places. The vegetative vigor is largely centered in the ends of the branches and twigs, and a moderate thinning out or cutting back of branches is practiced in the annual pruning.

IMPERIAL EPINEUSE

Tree upright spreading, vigorous, branches freely, and retains spurs for many years.

Spurs form at almost all nodes along the new shoots and larger twigs and along the terminal portion of the smaller twigs. They remain thrifty and productive even along the old framework branches if the tree has been kept open. They are rather long and often produce several branches which provide an abundance of fruiting surface. The spurs are very strong and are seldom broken from the branch. If they die or are broken off they are seldom replaced by new ones. In the hotter, nonirrigated sections spurs form at terminals of almost all twigs and branches, and the tree increases in size but little if the branches are not headed back (pl. 26, A). Under cultural conditions favorable for wood growth the spurs are longer than otherwise, especially if fruit crops are light, a branch of the spur often growing to a short twig and the fruiting branch becoming well set with fruiting twigs (pl. 26, B).

New shoots or twigs may spring from spurs either young or old in any part of the tree that is given light if the tree is vigorous. When pruned, the new shoots usually grow from spurs immediately below where a branch was cut back, but they may start from spurs on any part of the cut-back branch or even from the main branch near where a branch was removed (pl. 26, C).

The tendency is for the spur to maintain a more or less uniform vigor in all parts of the tree rather than in a restricted portion of it. This tendency is more pronounced with this than with most other varieties. The Sergeant is an exception.

In the hot irrigated sections the new growth on unpruned trees is short and but few branches are produced to replace those removed in thinning. Here an open tree of strong branches may be maintained with but a minimum of pruning after the tree has been formed (pl. 26, A). In the cooler coastal regions the wood growth is more vigorous than in the hotter valleys, and the tree tops are inclined to become dense, making more thinning necessary to prevent excessive shading in the interior part of the tree. In irrigated orchards in cool sections, trees severely headed back each winter produce vigorous upright shoots at the top (pl. 26, D). Under this treatment twigs grow from one or more branches of almost all spurs throughout the tree, and heavy crops are borne both by the branches of the spur which did not grow to twigs and by spurs which developed on new twigs (pl. 26, E).

The fruit is borne throughout the tree and almost entirely on spurs with leaves. On wood 1 and 2 years old the crop is light, but on spurs on wood 2 years old or older it is more or less uniform throughout the tree. On 1-year-old wood any fruit produced is found mostly at nodes where spurs are forming. Some fruit is found along the leafless section near the base of the slender 1-year-old twigs and on the larger 1-year-old shoots. Some spurs set fruit along

the lower portion of the more slender 2-year-old twigs, but these fail to produce leaves. This is more often true in the interior of compact trees where the spurs die after harvest.

ITALIAN PRUNE

Tree round topped, moderately vigorous, rather open, inclined to make but few framework branches, but to produce many small fruiting branches and twigs.

The Italian Prune is probably more inclined to produce twigs instead of spurs than any other variety commercially cultivated in the Pacific States, fruiting twigs being produced at almost all nodes of the larger and more vigorous shoots (pl. 27, A). On these twigs and on small branches the fruiting twigs make but little growth during the first season, often resembling spurs, but they grow to longer twigs the following year or die after producing fruit. The fruiting branches, although vigorous and long lived and inclined to send out numerous twigs, make but little diameter or length growth; and after a few years without thinning out, their twigs increase in length from year to year, forming brushes of fruiting wood which droop badly (pl. 27, B). The smaller branches remain slender and bend readily with a load of fruit, and if they retain their bending position, sunburning of the main branch often results (pl. 27, C). The twigs are sensitive to shade, and with the accumulation of outer branches much fruiting wood through the interior of the tree disappears (pl. 28, A).

Vigorous new shoots spring from near the end of large new branches which have been headed back and from headed-back old branches, although only slight shortening of old branches induces but little new growth except a moderate lengthening of the fruiting twigs near the end of the branch. By heading back the young trees or thinning the branches in older ones, large, erect, new shoots are readily produced. Shoots which form the large branches increase in length but little after they are a few years old, unless they are headed back to induce the growth of new shoots. In this they contrast with shoots of California Blue, Sergeant, and some other varieties. Where growing conditions are unfavorable and the outer part of the tree becomes dense, the secondary branches remain slender and become drooping, and injury by sunburning is common. Under good growing conditions large, erect shoots which may appear send out many short lateral fruiting branches, which gradually increase in length and rebranch, thereby providing much fruiting wood.

Fruit is borne almost entirely on leafless nodes on 1-year-old twigs (pl. 27, A). Along 1-year-old branches which are below normal in vigor, twigs usually fail to make more than a short spurlike growth. Such twigs often bear no leaves or only small leaflets and die after the fruit ripens, if they bear fruit. On the vigorous branches such spurlike twigs occasionally bear fruit and continue growth to longer twigs; but as this is not common, the yearly extension of the older twigs is needed to supply the fruiting wood.

Pruning to thin out and reduce the number of twigs sufficient to induce a vigorous growth of twigs on the remaining branches and removing or heading back some large branches to induce the replacement of old fruiting branches with vigorous new ones should result in the vigor required for good fruit production (pl. 28, B).

Observations on this variety have been confined very largely to orchards in the Pacific Northwest, where it is the principal commercial variety.

JEFFERSON

Tree only moderately vigorous, upright spreading, very open, makes few fruiting branches, and produces spurs instead of twigs. Most of the new growth appears on spurs and at terminals of branches. This variety is very prolific and inclined to be regular in bearing, and when in full bearing little wood growth is made. It is adapted only to soils which are deep and fertile (pl. 29, A).

Large new shoots spring from the stubs of branches which have been headed back, near where branches have been removed, and also from the terminals of spurs and branches in any part of the tree. The Jefferson produces fewer large shoots, however, than most other varieties. If the new growth is regu-

larly and heavily headed back in winter, numerous twigs, although few long shoots, grow from terminals of spurs. If the tree is kept open by thinning and occasionally headed back, vigorous shoots sometimes grow from the terminals of spurs and branches as well as from near points of pruning; but most new growth will be that of small shoots and twigs growing from spurs in any part of the tree. The shoots which grow from terminals of spurs, like those induced to grow by the cutting back or removal of small branches, are usually short but are stocky, prolific, and produce numerous spurs.

Spurs develop at almost all nodes of 1-year wood except on any slender twigs which grow from spurs on trees which have been severely headed back. They are very prolific and persistent, 20-year-old ones well set with fruit having been found. They branch freely, and as the internodes of the wood on which they grow are often short there is an abundance of fruiting wood (pl. 29, B and D). If trees are severely headed back each winter many spurs grow to twigs and but few spurs remain along the older wood (pl. 29, C).

Fruit is borne almost entirely on spurs, except on heavily pruned trees where spurs have grown to twigs. On these trees fruit is often found at leafless nodes on the 1-year-old twigs. The crop is usually light at 1-year-old nodes where spurs are forming, but spurs 1 year old and older bear well and also make a good leaf growth. The thick stand of much-branched and prolific spurs causes the fruiting branches to bend badly when fruiting, and thorough thinning of fruit and often propping of branches is necessary.

Trees of the Jefferson variety are very prolific, but inclined to make little wood growth after they have reached full bearing. Therefore care should be taken to maintain vegetative vigor by regular pruning and other cultural treatments. In pruning, cutting back should be confined to the shortening or removal of small branches, as wounds heal slowly; if large branches are removed decay often enters. The danger from wood decay makes it necessary to give special attention to the training of the young tree, so that the removal of large branches in later years will be unnecessary.

PEACH

Tree moderately vigorous, upright spreading, and produces and retains spurs and fruiting twigs throughout the entire tree. The new wood growth is usually from the ends of the branches, and but little growth appears on twigs and spurs except where stimulated by pruning or where other conditions have changed and become more favorable to wood growth.

Spurs form freely on all twigs and branches, and where conditions are favorable they remain as spurs for many years. The influence of pruning is less marked on spurs of this sort than on most other varieties. They are, however, somewhat susceptible to injury from dense shade caused by the compact tops of heavily headed-back trees. As with other varieties, a heavy wood growth follows heading back in pruning; but the vegetative vigor in trees of this variety is centered largely near the points of pruning, with the result that a greater portion of the new growth appears near the point of pruning than is found with other varieties (pl. 30, A). Trees severely headed back form dense new tops which shade the interior of the tree, while there is but little increase in growth or vigor of spurs or twigs lower in the tree.

The fruit is borne throughout the tree on spurs of all ages and at nodes where spurs are forming on 1-year-old twigs and branches. The twigs and smaller 1-year-old branches bear heavily, and as with other varieties only a little fruit sets on large 1-year-old branches. Fruit is seldom found at leafless nodes except near the base of 1-year-old wood, and here the leafless segment is comparatively short. The Peach resembles the California Blue in retaining spurs in all parts of the tree, replacing any spurs which were broken off with new ones and bearing fruit on spurs of all ages. It also resembles it in fruit characteristics.

In training the young tree a goodly number of framework branches should be developed, for the reason that the fruit is borne mostly on twigs and spurs which are retained along the entire length of the old branches. Danger of their breaking or the need for props is thus decidedly less than with most varieties. In pruning, the tree should be kept open by the thinning of branches rather than by heading back, as heading back centers the vegetative vigor in the upper part of the tree.

POND (HUNGARIAN PRUNE)

Tree moderately vigorous, upright, open, inclined to make but few main branches other than the long rank shoots which grow up from stubs of branches which have been cut back or along the main branches of heavily pruned trees. Under good growing conditions it makes a moderate quantity of new wood, but is readily influenced by pruning. The quantity of wood which it develops is determined more by local and cultural conditions than is the case with most varieties. It is very sensitive to drought, and if unirrigated severe cutting back and pruning are required to maintain vigorous fruiting wood, and the crops are below those in irrigated orchards (pl. 30, B).

The long, erect shoots which grow on headed-back trees have few branches, and the short, lateral twigs and fruiting branches which develop well out on them do not appear near the base. If these shoots are not headed back they will bend badly with the loads of fruit, and both fruit and branches will be exposed to serious injury by sunburn. Where regularly headed back, the tops of trees not thinned out become sufficiently dense to cause the dying out of the smaller branches in the interior of the tree, which in this variety are very sensitive to shade.

The fruiting branches and twigs, aside from small spurlike twigs which appear on the 1-year-old wood, are for the most part slender and branch but little if not induced to do so by being cut back (pl. 30, C). As a rule, the lateral spurs and twigs are short lived where shaded or on unthrifty trees. Aside from the branching along the larger 1-year-old shoots, the production of fruiting wood results from the outgrowth of terminals of twigs and fruiting branches. These increase in length from year to year, and an occasional new twig will grow from a lateral bud of a twig (pl. 30, C and D).

The Pond variety is inclined to form twigs and branches instead of spurs, although many twigs which appear on the larger 1-year-old branches make so little growth in length during the first season that they may be called spurs. Much of the terminal growth made by bearing, unpruned trees, especially where the trees are not irrigated, is but little longer than the spurs of other varieties. The lateral spurs which do not grow out to form twigs usually die after fruiting. This indicates the need of a continued renewal of the fruiting wood, since the tendency of this variety is to produce twigs rather than spurs, and good crops can not be expected where these twigs make only a short spurlike growth.

New twigs seldom replace those removed by pruning or accident, so the fruiting wood is seriously reduced when the trees are severely headed back and the fruiting branches thinned. Regular and moderate cutting back of both the large 1-year-old shoots and the smaller branches results in a vigorous growth of fruiting wood.

Trees which are growing well bear their fruit chiefly on wood 1 and 2 years old, whereas with unthrifty trees much of the fruit is on the short spurlike growth at the end of branches. On 1-year wood which has made but a slender or poor growth the first season, the fruit usually appears near the base and at leafless nodes which will remain barren after the fruit harvest. Along the 2-year-old wood considerable fruit is borne on 1-year short spurlike twigs which are also leafless, and all will die after the fruit ripens except a few of the most vigorous which grow to twigs (pl. 30, C).

The decided tendency of this variety to bear fruit only on the young wood and of this wood to remain barren after once fruiting, suggests the need of a thrifty growth to maintain the desired fruiting wood.

In habits of growth and production the Pond resembles the Bradshaw and the Giant rather closely, although the trees of the Giant are more vigorous and if well irrigated often produce a more satisfactory number of new fruiting twigs without pruning. Less pruning is required for Giant under an unfavorable environment than for the Pond or Bradshaw.

PRESIDENT

Tree moderately vigorous, upright spreading, open, inclined to branch but little if not cut back in pruning, and produces large fruit spurs which on a thrifty open tree are maintained throughout the top. The leaves are large and heavy, and large clusters of them form on spurs throughout the tree. Because of the lack of branching, the trees are usually sufficiently open for the admission of an abundance of light (pl. 31, A, B, and C).

Vigorous shoots grow from branches which have been headed back and occasionally in well-open trees from points near where other branches have been removed, but seldom from unpruned parts of the branch. With trees which have had the new growth severely headed back each year the tendency is to make but little twig or branch growth along the older portion of the branches, and the new branches here are usually frail. The large new shoots, as well as smaller branches and twigs, soon terminate in spurs if not headed back to promote wood growth.

Large, thrifty spurs form at almost all nodes of medium and large-sized 1-year-old shoots except at the section near the base, although little fruit is borne on the 1-year-old shoots. On medium and small-sized 1-year shoots, considerable fruit is borne at leafless nodes near the base of the shoot, with the section beyond producing spurs. Where the new growth is short one-half or more of its length produces no leaves after the first summer; and in unirrigated sections where almost all new growth on bearing trees is short, heading back, sometimes into older wood, is necessary to induce a vigorous new growth (pl. 31, D). On slender twigs all nodes except those near the tip remain leafless, although fruit is borne at some of them (pl. 32, A).

Along the lower, heavier portion of the vigorously growing shoots, occasional twigs or spurs are produced during the first season (pl. 32, B). These grow at right angles to the branch and sometimes reach from a few inches to a foot or more in length, are stout, and bear well when 1 year old. Fruit is borne at leafless nodes, leaving the twig barren thereafter, with the exception of a few spurs near the end. This type of fruiting wood is seldom found and on only a few varieties. The number and length of these twigs depend upon the vigor of the new shoot, which is seldom sufficient to cause their growth unless the tree was heavily cut back the previous winter. Slender spurlike twigs, which grow at right angles to the new shoots, appear also when the growth of the new wood is checked during the summer; and, in this case, they appear upon small as well as large new shoots and are usually well out toward the end of the new shoot. The long spurlike twigs, like the shorter spurs, do not increase in length after the first season, but both remain vigorous and productive over a period of years (pl. 32, C).

When the new shoots make an exceptionally rampant growth, such as sometimes occurs on trees heavily headed back or recently top-worked, numerous long slender twigs instead of short spurlike twigs or spurs appear on the new shoots early in the season. These twigs bear fruit heavily when 1 year of age but are usually frail and die at the end of their second summer or produce only a few short spurs near the end.

The fruit spurs grow to considerable length during the first season, increase in length but little thereafter, are large in diameter, rather easily broken, and quickly injured by shade. Those along older branches lose vigor if the new growth is regularly and heavily headed back, causing a heavy top growth, and those which die or are broken off are seldom replaced. The older branches therefore become more barren from year to year if care is not taken to prevent the breaking of spurs and to retain their vigor by maintaining an open tree. The spurs branch freely, becoming more spreading than those of most varieties of Japanese plums, but they remain more compact than the spurs of most varieties of the domestica group.

Where there is no irrigation or where other conditions are unfavorable to wood growth, the new wood is short and slender, and large portions of the new branches fail to produce leaves except near the end. If spurs are produced they will bear heavily at 1 year of age, and all except those near the end will die after the fruit harvest. Where such a twig or branch is cut back, removing the section of leaves, the remaining part will die back to the main branch after the fruit ripens. In this way the young spurs, side branches, and all twigs along the older branches soon disappear on trees which grow poorly.

Because the tree is inclined to produce new shoots near the point of heading back only and to produce vigorous long-lived spurs on the remaining portion of the 1-year-old wood (if it was this which was cut back) and along all vigorous shoots which were not pruned, heading back should be practiced to encourage branching while the tree is young. Subsequently, sufficient thinning out and heading back should be done to keep the tree open for the admission of light to the fruit spurs and to induce sufficient new growth to maintain a strong vegetative vigor. In unirrigated sections the new growth of the shoots

is short, and fruit, instead of spurs, is produced near the base of them. This leaves this portion of the branch barren the next year, and heading back below spurs is necessary to induce the desired wood growth. The leaders are then barren except for the new annual growth at the end (pl. 31, D). In such localities it is necessary to practice rather severe annual heading back to stimulate the growth of the needed fruiting wood.

REINE CLAUDE

Tree open, round topped, and of moderate vigor. It produces numerous fruiting branches, but is not inclined to replace those which are removed in pruning. Fruiting twigs sometimes refill openings made by removing branches but under moderate thinning out the tree becomes very open unless headed back to induce wood growth.

In the production of fruiting wood the tendency is to form twigs rather than spurs. Numerous fruiting twigs are formed on the vigorous 1-year-old shoots (pl. 33, A). These form terminal spurs, under poor growing conditions, but continue to grow in length, becoming drooping twigs when conditions are such as to encourage wood growth. On the more slender 1-year-old shoots, short spurlike twigs instead of longer twigs are formed. If conditions are not favorable to wood growth, these are formed on all 1-year-old shoots, with few (if any) growing to twigs. If the short spurlike wood bears fruit it usually fails to produce leaves and dies after the fruit ripens. The vegetative vigor of the fruiting branches soon becomes low, and spurs are rarely produced on wood more than 1 year old. Spurs and twigs which die or are broken off are seldom replaced. Regular fruit production and moderate or slow wood growth result in long barren sections of the fruiting branch. Excessive fruit crops cause poor wood growth and loss of most young fruit spurs, but where the crop of fruit is light many of these are retained. The spurs which remain vigorous through their second summer are often retained for a number of years if conditions for wood growth are favorable, even if bearing good crops. Spurs and twigs along the terminal portion of the larger fruiting branches often remain thrifty for a few years even where the rest of the branches have remained barren after the first crop. Such branches produce heavy crops which cause them to droop. Where the vigor of the tree is not sufficient to cause a portion of the spurs to grow to twigs, the fruit is usually below the desired size (pl. 33, B). By heading back the stronger shoots, the development of twigs rather than spurs may be induced; and by the shortening of twigs, some spurs on them grow to twigs which would otherwise die after fruiting.

Where conditions for wood growth are exceptionally favorable and the new wood is well shortened each winter, almost no spurs will form, as all are stimulated to grow to twigs.

On vigorously growing trees fruit is borne at leafless nodes on 1-year-old twigs and on 1-year-old leafless spurs almost entirely, but on unpruned trees where for other reasons there has been but little wood growth it is found on spurs with leaves.

Bavay, a variety very similar to Reine Claude, is more inclined to form and retain spurs than is the Reine Claude, and the twigs are more inclined to terminate in spurs and remain short. The quantity of fruiting wood is therefore not so seriously reduced by heading back, but more pruning is required to maintain a vigorous twig growth.

SERGEANT (ROBE DE SERGEANT)

Tree very vigorous, upright, open, becomes larger and spreading by continuing the terminal growth of branches, and produces and maintains spurs well. It retains a strong vegetative vigor throughout the tree. If regularly headed back, trees with numerous framework and fruiting branches become compact by the growth of twigs; but where not headed back to induce the growth of new branches the loads of fruit soon cause them to become open and spreading (pl. 34, A and B).

By heading back or removing branches, large new shoots will be produced near points of pruning, although these shoots are not as a rule numerous. If the tree is open and growing slowly, a change in cultural treatment to favor wood growth will cause the development of new shoots in different parts of

the tree. Under conditions favorable to wood growth the branches continue to lengthen from year to year, although sending out but few if any fruiting branches, whereas under adverse growing conditions terminal fruit spurs form on the ends of branches (pl. 34, C). Because of the little branching, unpruned trees become very open if wood growth is slow; but with the appearance of twigs and small branches and the length growth of spurs, they maintain a good supply of fruiting wood.

Vigorous spurs are produced along the entire length of all branches and twigs and remain thrifty and productive throughout the tree, even under somewhat adverse growing conditions. The vigor of the spurs and the tendency for the tree to produce and retain them are more pronounced in this than in other varieties commonly grown (pl. 34, C). Where not crowded the spurs are much branched, and all branches make considerable terminal growth. The growth of spurs of this variety, which sometimes reaches a foot or more in length on old trees, is more pronounced than with other varieties; and by pruning or otherwise improving conditions for wood growth, a vigorous twig is often produced from a spur (pl. 35, A). Trees on which the 1-year wood is regularly and severely headed back produce an abundance of vigorous spurs and twigs throughout the tree (pl. 34, B, and pl. 35, B). Toward the end of vigorous young branches, short twigs sometimes appear in place of spurs. These twigs make a spreading growth of moderate length and produce numerous fruit spurs which bear a heavy crop, causing the longer and the more slender branches to spread or droop.

Fruit is borne almost entirely on growing spurs and at nodes of short 1-year branches where spurs or twigs are forming. This indicates the strong vegetative vigor of the fruit wood of this variety. The fruit is often numerous on short, compact much-divided spurs on wood 2 and 3 years old where the spurs have made but little growth in length. The strong tendency to form spurs at all nodes of the 1-year-old branches leaves but few barren nodes in any part of the tree, even where heavy crops are borne on the young wood.

Pruning to establish a good number of framework branches, shortening these to establish and maintain strong upright branches, and developing spurs and twigs on them should result in a productive and satisfactory tree. Although trees of this variety are often left unpruned, they will probably withstand severe pruning with as little ill effect as any commercially grown variety. If the soil is fertile and well watered, they will continue thrifty and produce with little pruning.

Although the size and shape of trees of this variety are greatly influenced by environment, their growth and ability to stand drought are shown by the persistence of their spurs and the thrifty green color of their foliage, which often remains for a considerable period after drought has caused leaves of other varieties to become discolored or to fall.

SUGAR

Tree very prolific, only moderately vigorous. It branches sparingly with the exception of the growth of twigs and spurs and is therefore naturally open. The branches are inclined to be more slender than those of most varieties, and they increase in diameter very slowly if not headed back to induce branching. The tree is inclined to produce new shoots from the terminals of branches rather than to form new branches, and there is but little terminal growth of unpruned branches after the first few years unless other conditions are very favorable.

Bearing trees produce almost no branches aside from those which appear following pruning; but by regular heading back the new shoots make a moderate upright growth, starting from the nodes of the 1-year-old stubs, so that by regular heading back a compact upright tree may be developed (pl. 36, A). As the new shoots start from near the point of pruning it is important that the supply of 1-year-old wood left after pruning be the length desired before the next branching takes place. If long sections of the 1-year shoots are left in pruning, the trees will be too open and the larger part of the fruit crop will be at a greater distance from the ground than is necessary. Although the shoots which grow from headed-back branches are fewer than are found on most varieties and shoots seldom appear along the older wood, many twigs and short branches which are the outgrowth of spurs are produced along the older branches of trees which have been headed back. This growth remains

thrifty for years if not in dense shade and if the conditions are favorable for wood growth.

Spurs of the short twig type are produced at almost all nodes of the 1-year-old shoots, and those on the older branches soon grow to twigs. If the trees have been cut back or are growing well, new spurs are in turn produced by the vigorous twigs which are the outgrowth of spurs. If prevailing conditions are adverse to wood growth almost all spurs remain short, although they may become much branched after a few years; and many of those along the basal portion of each season's wood disappear. The spurs which form well out on the shoot live for a number of years, but seldom produce twigs if the branch is not cut back, but they bear well and so cause the branch to bend with the heavy load of fruit. This condition often results in their bearing only in alternate years.

Fruit is borne on spurs in all parts of the tree and on nodes of 1-year-old twigs throughout the tree, but they are rarely found on large 1-year shoots. The nodes of the more slender 1-year-old twigs are usually leafless if bearing fruit, although near the base of the heavier twigs spurs are sometimes formed at fruiting nodes.

TRAGEDY

Tree round topped, rather open, moderately vigorous, produces both fruit spurs and small fruiting twigs and retains them throughout the tree. In the performance and vigor of the fruiting wood, or the spurs and twigs, the Tragedy is probably influenced less by pruning than any of the other domestica varieties. The tree grows normally over a wide latitude and with greatly differing summer temperatures. It is quickly affected by drought and not extensively grown where water for irrigation is not available, because either the fruit will be of small size or, if pruning is sufficient to induce the development of large sizes, only enough fruiting wood will remain to produce a light crop.

Fruit spurs and twigs grow freely along both large and small 1-year-old wood and, under moderate growing conditions, are vigorous and productive over a period of years (pl. 36, B and C). The small twigs make only a moderate terminal growth if the tree is fruiting well, but vigorous fruit spurs form on them. These are rather strong and not easily broken from the branch and under conditions favoring wood growth make considerable terminal growth (pl. 37, A). By pruning the twigs or spurs or by removing branches which grow near them they are often induced to make some terminal growth, and new twigs may appear; but this twig growth is less marked than with most twig-producing varieties. The new shoots which appear following heading back are, however, large and vigorous with the Tragedy, as with other varieties. Spurs and twigs of vigorous trees branch freely if given light; but if shaded or if the trees are in need of irrigation or pruning, many disappear after fruiting, and the new wood growth is short. In shallow soils and where roots are unthrifty or the stock uncongenial, a proportionately greater number of spurs than twigs will be formed (pl. 37, B). Even under surroundings favorable to wood growth, the development of secondary or fruiting branches is inclined to be checked early in their growth in favor of the development of lateral twigs and spurs. In this case the vegetative vigor can be maintained and the desired growth and shape of the trees obtained by heading back the thrifty 1-year-old shoots. This can be done with but a moderate sacrifice of fruiting wood lower in the tree, if there is sufficient thinning of branches to admit light. Pruning has a more moderate influence on the growth of fruiting wood of Tragedy than on most varieties (pl. 36, C).

Heavy new shoots appear near the end of stubs of branches which have been headed back and near where branches have been removed in other parts of the tree. They make a rapid erect growth and do not branch during the first season but produce numerous lateral spurs and a few twigs when 1 year old. Under poor growing conditions spurs only will be produced. When bearing heavy crops the large unpruned shoots make but little terminal growth.

Fruit is borne for the most part on growing spurs of wood of all ages, although occasionally on leafless nodes on the more slender 1-year wood, on leafless spurs of unthrifty trees, and in shaded parts of the tree.

The tendency of the Tragedy to form thrifty fruit spurs and twigs and to retain them throughout the tree, until they are eliminated by shade, and the growing of vigorous new branches from old as well as from new wood are indications of the vegetative vigor that is retained throughout the tree and of

the possibility of developing and maintaining the desired form of tree by consistent pruning. It is evident from the slow growth of branches and the dying out of shaded ones, as well as from the small-sized fruit produced by compact trees, that a moderate thinning out is necessary to maintain a thrifty, moderately open tree.

WASHINGTON

Tree upright spreading, vigorous, and produces numerous twigs and spurs. The spurs which form thickly on the vigorous 1-year-old wood are usually short lived if they fruit well, leaving much of the older wood barren if the tree is at all compact and prolific. The manner of growth is very readily influenced by cultural treatment and environment. If the soil is fertile and irrigated, regular thinning out and light heading back result in the growth of numerous vigorous twigs, but severe heading back results in the growth of many large vigorous shoots. The leaves on these shoots and in other parts of the tree are large and form dense shade in the interior of the tree. This is accompanied by loss of much fruiting wood, for if the branches become barren they usually remain so. If the trees lack for moisture the twigs are short and soon lose their fruit spurs.

New shoots spring from near the point of heading back or at points where branches have been removed along the portion of the branch which is only a few years old. They are not common in other parts of the tree. Twigs and spurlike twigs form along the 1-year shoots and twigs, and if the tree is thinned out and moderately headed back in pruning many of the short spurlike twigs grow to thrifty twigs the following summer (pl. 38, A). If little or no pruning is done, few shoots will be produced and the terminals of shoots and twigs will be very short, especially on older trees, often of spur length only.

Fruit is borne mostly on 1 and 2 year spurs and at nodes on 1-year-old twigs. Fruiting nodes seldom produce leaves, and many of the bearing spurs are leafless and die after the fruit ripens, especially on twigs which have made considerable terminal growth the previous year. If the tree is kept open and only moderately headed back at pruning time, many fruiting spurs make moderate growth in length. On thrifty young trees and vigorous shoots of older ones the crop on 1-year-old spurs is often light.

In the cool coastal region of California, trees which have been severely headed back each year grow luxuriantly. In their vigorous growth they contrast with trees of Grand Duke and Diamond, also of the domestica group (pl. 3, B and C; pl. 20, B).

YELLOW EGG

Tree upright spreading, open, moderately vigorous, sensitive to poor soil and drought, and under poor growing conditions the branches soon become barren.

Vigorous shoots spring from near the end of cut-back branches. Under good growing conditions these increase in length from year to year by the outgrowth of the terminal bud, and they send out strong lateral branches. Where lightly pruned and not irrigated, the new growth on both large and small branches is very short. On the lighter soils there is less branching than elsewhere, short-lived spurs are formed in place of twigs and branches, the new growth is slender, and few fruiting twigs are retained. Under conditions favorable to wood growth only a few spurs are formed, as the lateral growth develops into twigs instead of spurs. On unpruned or lightly pruned trees or those making a slow growth, much of the lateral growth from the 1-year-old shoots is short and soon disappears, leaving much of the branch barren (pl. 38, B). The slender 1-year shoots produce few lateral spurs or twigs, so that the entire twig is barren with the exception of a few nodes near the tip.

There is considerable difference in length and vigor of fruiting twigs. They are all slender, and the shorter ones often die after bearing one or two crops of fruit. This tends to keep the tree open and permits the larger twigs to continue their length growth. These slender twigs continue to lengthen and become drooping, and if the growth is encouraged by heading back they produce lateral twigs and spurs which bear well (pl. 38, C). Twigs in the upper and outer part of thriftily growing trees which increase their length only a few inches each year soon die; whereas in the lower portion of open trees twigs are often retained for a considerable time, although making a short annual growth. If twigs or spurs are not formed, are broken off, or die, the branch remains barren, as new growth rarely appears on old wood except

where large branches have been headed back or removed. Where growing conditions are poor, the branches of trees of this variety are slender in proportion to their length, and more so than with most other varieties which produce twigs rather than spurs. With the slenderness of branches is the tendency to be barren after bearing a crop of fruit, to bear light crops of small fruit, to branch little, and to lose many twigs soon after they are produced (pl. 38, D).

Fruit is borne almost entirely at leafless nodes of 1-year twigs and on 1-year-old spurs. The bearing spurs are usually without leaves, except that occasional bearing spurs on a thrifty tree produce twigs.

Wounds left where large branches are removed heal very slowly; therefore, pruning should be confined to the smaller ones as much as possible.

NEW OR LITTLE-KNOWN VARIETIES

Burton.—Trees of this new domestica variety resemble the Imperial Epineuse both in form of tree and in the growth of spurs and small branches (pl. 39, A). In general, a pruning practice suitable for the Imperial Epineuse appears to be suitable for the Burton. Near Vacaville, Calif., the only section where this variety has been in bearing, it has borne heavy and regular crops of fruit for a number of years. Because of its productiveness, somewhat more pruning is required to maintain the desired wood growth than is needed by the Imperial Epineuse, which in many localities is a light and irregular bearer.

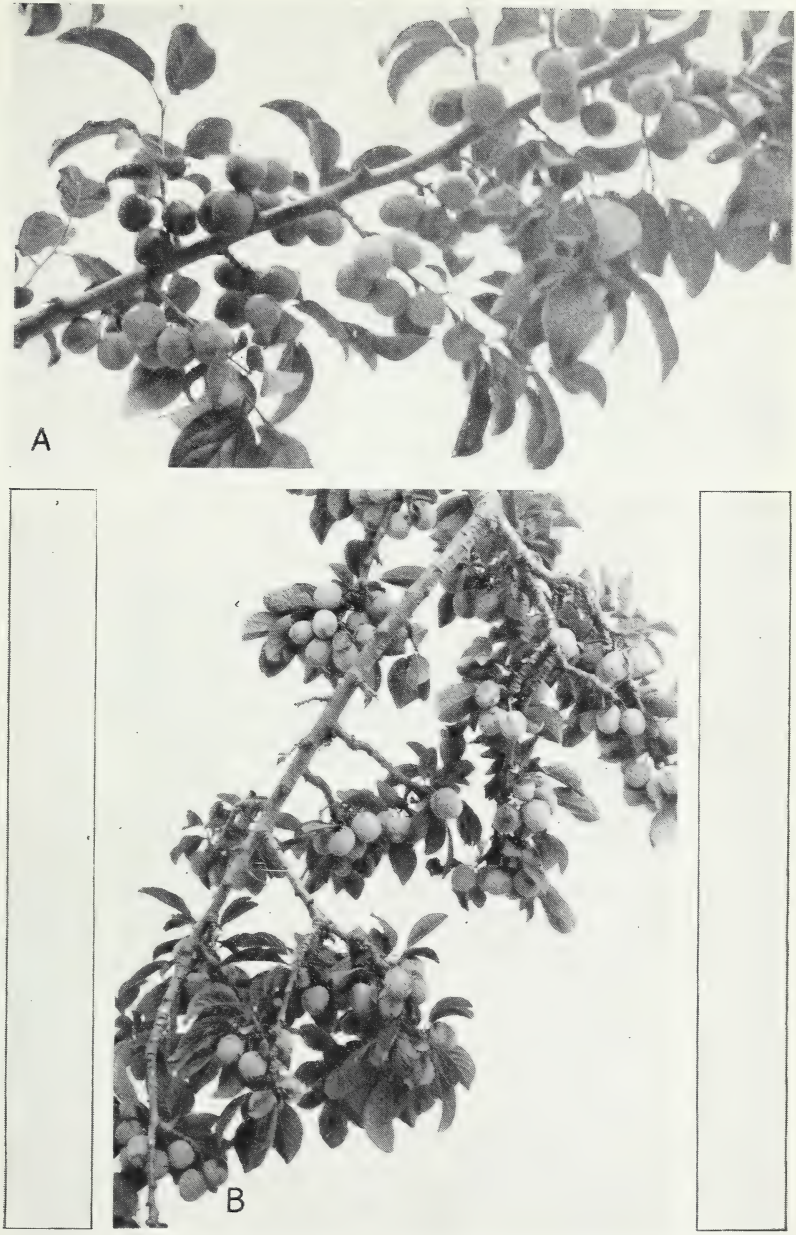
Stuart.—This also is a domestica variety. The trees appear to be almost identical with the Imperial Epineuse in their habits of growth, and therefore the same pruning practice is applicable to both. Bearing trees have been observed only in the north-central part of the San Joaquin Valley in California. Like the Burton, trees of this variety have been more prolific than those of Imperial Epineuse growing beside them. Its fruit also resembles the fruit of the Imperial Epineuse very closely, whereas the fruit of Burton is of an amber color and in shape resembles the Agen more than the Imperial Epineuse.

Sweetheart.—This domestica variety has been observed near Courtland, Calif., where it originated. This is the only place it is growing commercially. It is included here on account of the peculiar habits of its fruiting wood. The tree is moderately thrifty, very prolific, has upright spreading open top, and produces and retains numerous spurs and spurlike twigs (pl. 39, B). The spurs or spurlike twigs form thickly along the 1-year-old wood and where they are not broken off or injured by shade are retained for a number of years. They are slender and branch freely, and considerable terminal growth takes place on each of the branches. There is often a main spur leader, however, which somewhat outgrows the other branches of the spur (pl. 39, C). In shaded places there are few branches on the spurs, although the tree is naturally open, and injury from shade seldom results. The fruit is borne at leafless nodes of both spurs and the twigs which grow from them in all parts of the tree.

Becky Smith.—Bearing trees of this Japanese sort have been observed only in the fertile, unirrigated section near Vacaville, Calif. The tree is upright, vigorous, and inclined to produce numerous framework branches if headed back. Otherwise it branches little, except for the production of numerous small fruiting branches and twigs. These are retained along the entire length of the branches. The twigs grow to several inches in length and are well set with short prolific spurs. Pruning to develop numerous secondary branches and heading back and thinning out to maintain vegetative vigor and to prevent shading of twigs in the interior of the trees appear to be desirable in pruning.

COMPARISON OF BEHAVIOR OF PLUMS UNDER EASTERN AND WESTERN CONDITIONS

In plum-growing sections of the United States other than where these studies were conducted the benefit derived from the observations presented will be of a fundamental nature only. In those regions, bearing plum trees of the same varieties as those considered here are pruned little, if at all, and only rarely to the extent commonly prac-



GROWTH AND FRUITING HABITS OF THE REINE CLAUDE PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A vigorous 3-year-old fruiting branch which was cut back when 1 year old. The tree is growing in very fertile well-irrigated soil

B.—Old drooping fruiting branches of a tree which is making a poor growth and on which the fruit will be small when the crop is heavy. The tree is growing in deep soil, not irrigated, and has not been pruned for several years

GROWTH AND FRUIT-SPUR DEVELOPMENT OF THE SERGEANT PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A 25-year-old tree which has been lightly pruned for several years and is growing in fertile unirrigated soil. Note the open growth and spreading branches. (Vacaville, Calif.)

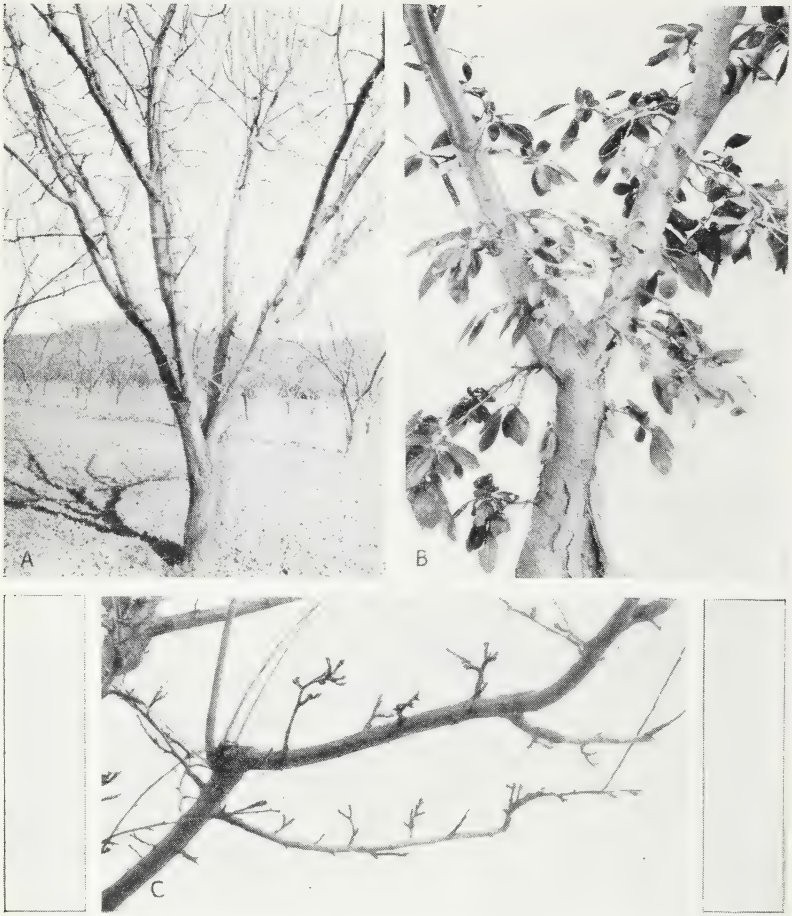
B.—A 16-year-old tree on which the new shoots have been severely headed back each year. There are comparatively few large new shoots, but the spurs and twigs are making a vigorous growth throughout the tree

C.—A 16-year-old fruiting branch of a tree which has not been pruned for several years and is growing in very heavy unirrigated soil where wood growth is exceptionally slow. Note the persistence and branching of all the old spurs which were formed when the branch was young. Also note lack of any new twigs or shoots

SPUR DEVELOPMENT AND FRUITING HABIT OF THE SERGEANT PLUM IN RESPONSE TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—Spurs 14 years old from large branches of an old open-headed tree which has been moderately pruned and is growing in fertile irrigated soil. Shoots and twigs often grow from spurs on vigorous Sergeant trees

B.—Framework branch of the tree shown in Plate 34, B

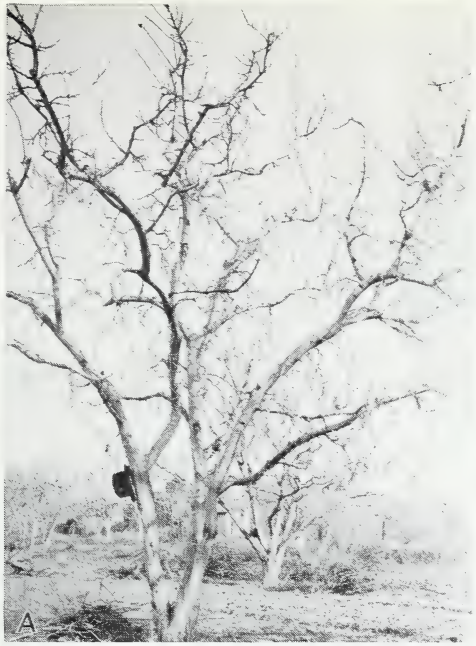


GROWTH AND FRUIT-SPUR DEVELOPMENT OF SUGAR AND TRAGEDY PLUMS IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A 6-year-old Sugar plum tree which has been headed back at different times to induce branching and has been kept open to encourage the growth of twigs along the older wood

B.—Base of 14-year-old framework branches of a Tragedy plum tree, the branches of which have been kept well thinned out and only lightly headed back. Under these conditions spurs and twigs remain thrifty and productive along the older portions of the branches. The tree is growing in deep irrigated soil. (Compare with pl. 37, A. Wenatchee, Wash., August 5, 1923)

C —A 10-year-old framework branch of the Tragedy plum which is growing in only moderately deep irrigated soil. The new shoots have been headed back and thinned out each winter. Note the strong new shoots and the retention of fruit spurs. (Placer County, Calif., December, 1923)



GROWTH AND SPUR DEVELOPMENT OF THE TRAGEDY PLUM IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—An old tree which has been kept well thinned out but only lightly headed back. Note growth of twigs and spurs. Annual pruning of new shoots has just been finished. Tree growing in deep irrigated land. (Courtland, Calif., January, 1924)

B.—The 10-year-old framework branch of a tree which has an unthrifty stock. Spurs rather than twigs or shoots form on unthrifty trees. (Compare with pl. 36, B)

GROWTH AND FRUITING HABITS OF WASHINGTON AND YELLOW EGG PLUMS IN RELATION TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—A portion of a vigorous old Washington plum tree which has been headed back and thinned out each winter. Careful thinning of these twigs is needed to reduce the crop of fruit and prevent shading. Note the numerous twigs and shoots. (Courtland, Calif.)

B.—Branch of moderately vigorous Yellow Egg plum tree which has not been cut back recently. The current season's growth at the end of the branch is short. Below this, spurs are forming on the 1-year-old wood. The most vigorous twigs on the 2-year-old wood are making some terminal growth. The short ones are bearing fruit, but have no leaves and will die after the fruit ripens. The spurs along the wood, 3 and 4 years old, died after fruiting

C.—Slender fruiting branches and twigs of Yellow Egg plum which have been cut back to encourage growth of new twigs. Note the fruit at leafless nodes and the absence of spurs, indicating the lack of a tendency to produce spurs on these vigorous branches

D.—A 9-year-old Yellow Egg plum tree on fertile irrigated soil. The new shoots have been headed back each winter to encourage the growth of fruiting branches and twigs. An abundance of vigorous fruiting wood has been developed. (Courtland, Calif.)

RESPONSE OF BURTON AND SWEETHEART PLUM TREES TO PRUNING AND TO SOIL AND OTHER CONDITIONS

A.—An 8-year-old Burton tree growing in fertile but unirrigated soil. This tree has been moderately headed back and the branches lightly thinned out each winter. Thrifty spurs are found throughout the tree. (Vacaville, Calif., August, 1924)

B.—An 18-year-old Sweetheart tree, photographed just after the 1-year shoots had been removed or headed back. Note the numerous and much-branched twiglike spurs along all branches. The tree is growing in fertile irrigated land. (Courtland, Calif., 1924)

C.—Six-year-old fruiting wood of a vigorous Sweetheart tree. (Compare with B)

ticed on the Pacific coast. Pruning is seldom relied upon for the development of large fruit, to maintain the vigor of the tree, or to reduce the crop of fruit, all of which are necessary in the more arid West, where unpruned trees often make a poor yearly growth and where only large fruits can be profitably transported to distant markets. The performance of the trees in the western regions is only an indication of what may be expected in the East, and local observations will be necessary if a detailed and intimate knowledge of the behavior of the varieties there is desired.

In general, the tendency to produce fruit spurs is less pronounced in the East than in the West, and the tendency to produce twigs is decidedly more pronounced. This results in a proportionately greater part of the crop being produced on the 1-year-old wood and in the trees becoming more compact. This variation in growth between the two sections of the country is much more marked with trees which in the West are inclined to produce spurs or both spurs and twigs than with those which are inclined to produce twigs rather than spurs. For example, the Italian Prune is distinctly a twig-forming variety in all the Pacific States; and in this, as well as in many other varietal characteristics in which orchardists are interested, little difference may be seen between them and trees of the same variety found in the plum-growing sections of New York and Michigan. With the Giant, which in the West is more inclined to produce twigs than spurs, no spurs whatever were found in the East, although the twig growth resembled that of the western trees closely. Trees of Agen, which are of the twig-producing rather than the spur-producing type, often form numerous spurs in the West if they are not pruned and have been bearing for some time or are under unfavorable conditions for wood growth, whereas a spur was rarely found on the eastern trees.

With most varieties which are typically spur producing the tendency for spurs to grow to twigs and therefore for the trees to become more compact and retain fewer spurs along the older wood is decidedly more pronounced in the East than in the West. Other examples of striking differences in habits of growth between eastern and western trees of the same varieties could be given. The Burbank tree is much more spreading or flat topped in the East than in the West. The Maynard is more open and more spreading; and Satsuma, Pond, and Lincoln are less vigorous and in comparison with other trees around them remain smaller than trees in the West growing beside the same varieties. The growth of trees of a few varieties, however, is almost alike in the two regions. Formosa and Italian Prune are good examples of this group.

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September 20, 1927

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